Entered as second-class matter at the Post Office at Philadelphia, Pa., under the Act of March 3, 1879.

AMERICAN JOURNAL OF PHARMACY

A RECORD OF THE PROGRESS OF PHARMACY AND THE ALLIED SCIENCES

VOL. 93 JULY, 1921 No. 7

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Price, $3.00 per Annum, in advance. Issued Monthly. Single Numbers, 30 Cents. Back Numbers, 50 Cents.

Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917. Authorized February 15, 1920.

PUBLISHED MONTHLY BY THE

PHILADELPHIA COLLEGE OF PHARMACY AND SCIENCE

145 North Tenth Street, Philadelphia

Treat Hay Fever with Suprarenalin

LABORATORY PRODUCTS

Suprarenalin is the remedy in Hay Fever. It may be administered locally, internally or Hypodermatically.

Locally—Solution and ointment are applied to affected parts.

Internally—Solution should be given, so that the patient will get from 1/10 to 1/15 of a grain; the dose repeated in from 10 minutes to 2 hours, according to effects.

(Let the patient hold Suprarenalin in the mouth for awhile, as the best systemic effects are got by absorption through the membranes.)

Hypodermatically — Suprarenalin Solution is injected into the arm or neck.

Suprarenalin is recommended in Hay Fever in various forms. Herewith are suggestions made by men of authority.

One recommends using solutions of varying strengths from 1:10,000 to 1:1000 made up with normal salt solution. To sustain the relief to some extent, he suggests spraying over the constricted mucous membrane a 5 grain to the ounce solution of menthol in albolene, benzoinol or other light oil.

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1. Suprarenalin ..... 1 part
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   Heavy Magnesium Carbonate .....800 parts
   Mix. Triturate well.
2. Suprarenalin ..... 1 part
   Zinc Oxide .....100 parts
   Bismuth subcarbonate .....400 parts
   Mix. Triturate well.
3. Suprarenal gland substance. 1 part
   Zinc Stearate ..... 20 parts
   Zinc Oxide ..... 80 parts
   Mix. Triturate well.
4. Suprarenalin ..... 1 part
   Bismuth subcarbonate .....300 parts
   Zinc Oxide .....300 parts
   Zinc Stearate .....200 parts
   Mix. Triturate well.

A prominent nose and throat specialist recommends:

	gm.	
Cocaine hydrochloridi.	15	or grs. iiss
Sodii benzic.	30	or grs. vss
Suprarenalin Sol. (1:1000)	4	or ʒi
Glycerine	2	or ʒss
Aquæ Camphoræ ad	30	or ʒi

M. Sig. Use as a spray to the nose four or five times daily or oftener if needed.

Suprarenalin Solution 1:1000 (Armour) is stable, uniform, non-irritating and is free from chemical preservatives. *Literature to Physicians.*

ARMOUR & COMPANY
CHICAGO

THE AMERICAN
JOURNAL OF PHARMACY

Vol. 93 July, 1921 No. 7

EDITORIAL

A BOUNDEN DUTY.

In the July, 1920, issue of this JOURNAL is an editorial, written by Mr. George M. Beringer, and entitled "The End of the Law is Obedience." Cleverly and carefully written, and chiefly concerned with a criticism of the attitude of certain pharmaceutical organizations in regard to the enforcement of Prohibition, it merits at this date, one year after its writing, a thorough study and an understanding of its deft argumentations.

Let the reader consult his files of the JOURNAL, turn to this editorial and read it once again. It is as pertinently impertinent and as impertinently pertinent today as upon the day of its writing.

We were drawn to it after looking over a certain resolution drafted and endorsed by the Pennsylvania Pharmaceutical Association, upon recommendation of the President, Mr. Sturgeon, at their recent meeting in Philadelphia. The particular resolution referred to follows:

"*Whereas,* the authorities at Washington have, without consulting the leaders of the drug industry and decidedly contrary to their wishes attempted to force the burden of carrying out the provisions of the Volstead Act upon the shoulders of the retail druggists, thus arbitrarily shifting the outlawed business of the saloon upon the druggists of the country, and

"*Whereas,* such action upon the part of the Treasury Department and the Internal Revenue Commissioner is repugnant to the reputable members of our profession and is hereby resented, therefore be it

"*Resolved,* that we earnestly recommend that no member of the Pennsylvania Pharmaceutical Association will permit himself or his pharmacy to be degraded in the estimation of the public by falling into the trap that has been laid to bring our business into disrepute by dispensing beer and wine, even upon physician's prescription, even under the false guise of their being for medicinal purposes."

The resolution does not bear a keen dissection, and, except for a high-sounding note of pseudo-altruism, there is nothing in it that savors of worthiness. That the Pennsylvania Pharmaceutical Association adopted such a creed is no unusual compliment to that usually carefully conducted body, except as we may look upon its adoption as having been hasty and without deliberation. The editorial referred to adeptly sums up our criticism of this poorly constructed resolution in the following statements:

"It is inconceivable that anywhere in these United States, it should not be recognized that the Eighteenth Amendment *prohibited* the manufacture, sale, transportation, importation or exportation of intoxicating liquors; that this and the Enforcement Act have outlawed 'the business of the saloon.' It is incomprehensible that a deliberate body, such as a pharmaceutical association is supposed to be, would now resolute about a business that the will of the people and the laws of the land had outlawed and even more so that they would even suggest that such a disreputable business was to be by the 'Government' 'forced' upon the retail druggist.

"The Volstead Act recognizes that the use of alcoholic liquors is necessary for the extraction, solution and preservation of medicinal preparation and rightly provides the means by which the druggist may obtain the supplies required for such uses. Further, that at times, certain distilled spirits and wines are considered by the attending physician as a therapeutic necessity, and it very carefully prescribes methods by which the physician may issue prescriptions for these in limited quantities, and then very rightly *considering that they are medicines directs that these shall be filled only through a pharmacist 'duly licensed under the laws of his State to compound and dispense medicine prescribed by a duly licensed physician.'* Is it not the legitimate duty of the licensed pharmacist and of no one else to dispense medicines? Is not this the very basic principle that has justified the enactment of pharmacy laws for the protection of the public against promiscuous and incompetent dispensing?

"This is an irrefutable statement of the law and the facts, and no perversion will justify an assertion or even an intimation that 'the Government' is desirous of providing for a continuation of 'the outlawed business of the saloon,' or of 'forcing it upon the retail druggist.'

"After all, the Mosaic injunction is a safe and worthy advice for pharmacists to follow:

" 'According to the sentence of the law which they shall teach thee, and according to the judgment which they shall tell thee, thou shalt do; thou shalt not decline from the sentence which they shall shew thee, to the right hand, nor to the left.' (Deut. 17: 12.)"

In our opinion a far worthier resolution was the one offered by Dean LaWall, of Philadelphia, and also adopted:

"*Resolved,* that the members of the Pennsylvania Pharmaceutical Association emphatically affirm that alcohol is a necessary solvent and preservative in the making of many valuable medicinal preparations, but we disapprove the illegal dispensing by pharmacists of alcoholic liquors or liquids, suitable for beverage purposes, and unanimously recommend the expulsion of any member convicted of such practice."

The Pennsylvania Pharmaceutical Association is to be congratulated upon its adoption of the latter resolution, but is amenable to criticism for its unwarranted adoption of the other resolution, which, in correctness, should never have been offered in session.

I. G.

ORIGINAL PAPERS

COMPARATIVE RESEARCHES ON THE METHODS PROPOSED FOR THE ESTIMATION OF GLYCYRRHIZIN IN LICORICE ROOT AND IN LICORICE EXTRACT.

By Armin Linz.

(*Prize Research of the Hagen-Bucholz Foundation, 1913-1914.*)
(*Archiv der Pharmazie,* 1916, Vol. 254, 65-134, and 204-224.)

TRANSLATED BY DR. PERCY A. HOUSEMAN. APRIL, 1921.

(*Continued From Page 414.*)

In controlling this method I obtained from 2.5 g. licorice 0.240, 0.249, 0.256, 0.257 g. of ammonium glycyrrhizinate, *i. e.,* 9.44-10.08 per cent.

The losses determined on 5 g. licorice amounted to 0.91-1.32 per cent. They are thus less than in the majority of similar determinations. The high value for ammonium glycyrrhizinate, as well as the slight losses show that the method is a practical one. The favorable result is to be ascribed to the use of ice water, and to the low temperature maintained throughout. The detailed procedure is not practicable since the awkward arrangement of freezing gives no better results than allowing to stand in ice.

10. Houseman (1912).

"Two g. licorice are dissolved in 10 cc. hot water in a centrifuge tube. After cooling, 20 cc. of 80 per cent. alcohol are added, and then gradually 50 cc. of 95 per cent. alcohol. The tube is centrifuged after standing two hours, the residue is stirred up twice with 80 per cent. alcohol, and again centrifuged. The liquid is poured off, and evaporated to dryness on the water bath in vacuum. The residue is transferred with 30 cc. water, to a small Erlenmeyer flask, and the glycyrrhizin, after cooling to 15°, is precipitated with 3 cc. dilute sulphuric acid (10 cc. H_2SO_4 to 300 cc. water). After standing two hours, the contents of the beaker are cooled for a half an hour in ice, and the clear liquid poured through a small filter. The glycyrrhizic acid is washed four times by decantation with ice water, the precipitated acid remaining in the flask, as well as any which has been transferred to the filter, is dissolved in dilute alcohol. Two drops of 5 per cent. ammonia are added to neutralize traces of sulphuric acid, and the solution evaporated to constant weight in a tared dish."

Houseman has modeled his method, as he himself states, upon that of Parry.

[TRANSLATOR'S NOTE.—This is not true. Parry obtained the translator's (Houseman) method confidentially, and published it as his own without acknowledgment. (P. A. H.)]

The new feature introduced is the centrifuge. The method has been worked out exactly by the author and gives detailed directions. He does not confine himself alone to the determination of glycyrrhizin, but also gives methods for determining the matters insoluble in cold and in hot water, starch, gums, and finally, sugar before and after inversion. Gums, etc., are precipitated by a large volume of alcohol. According to my view, as already stated in discussing Parry's method, a greater concentration of alcohol would have the danger of precipitating glycyrrhizin compounds. In order that any glycyrrhizin which is precipitated or remains undissolved, shall be obtained in the determination, Houseman centrifuges the precipitate twice more with 80 per cent. alcohol. The amount of alcohol used is, unfortunately, not stated. It would presumably answer the purpose, to warm the mixture somewhat before centrifuging, in order

that everything soluble might certainly be extracted. The alcoholic extract is to be evaporated, in vacuum, to dryness. Why this evaporation is to be carried so far, I cannot understand, and Houseman himself does not further offer reasons for the instruction. It suffices completely, to carry the evaporation until the alcohol is driven off. That Houseman has, in evaporating to dryness, reckoned with the possibility of decomposition, is proved by his care in evaporating in vacuo. I carried this out by connecting a water pump to the arm of a distilling flask and carefully evaporating. The heating took place on the water bath at as low a temperature as possible. Great care is necessary here on account of possible boiling over. In my opinion, this whole experimental arrangement is superfluous, since one can do without the unnecessary evaporation to dryness. The precipitation of glycyrrhizic acid takes place with dilute sulphuric, of the same strength used by Parry and Evans. Houseman allows the precipitated acid to stand only two hours, on the ground that 12 to 24 hours standing is superfluous, and gives lower results. I have observed the contrary and can here only state, that sulphuric acid, after standing longer than two hours, still gives a brown precipitate which sticks to the bottom of the vessel, and which is soluble in ammonia. According to my observations which I have made on a large number of analyses, standing from 10 to 12 hours is recommended. Houseman also makes use of the difficult solubility of glycyrrhizic acid in ice water, but avoids the false experimental conditions of Evans' Sons. He precipitates at 10°, and then places the vessel on ice. The purification of the acid, sticking on the bottom of the vessel, takes place by decanting four times with ice water. Unfortunately, Houseman mentions no quantities. I have already often stated that a good purification by decantation cannot well be carried out. The glycyrrhizic acid is weighed in this determination. When Houseman states in conclusion that he weighs pure glycyrrhizin, he is grossly deceiving himself.

[TRANSLATOR'S NOTE.—Houseman makes no such statement, but, on the contrary, expressly states that he weighs crude glycerrhizin. It is Linz who is grossly deceiving himself. (P. A. H.)]

The end product shows exactly the same color as all the other preparations obtained in a similar way. I obtained from 2 g. licorice 0.189, 0.193, 0.2 g. glycyrrhizic acid, *i. e.*, 9.45-10.0 per cent. I de-

termined the loss on 4 g. licorice. It corresponded to 1.0-1.25 per cent. of the licorice. The matter insoluble in the alcohol-water mixture was 50 per cent. In examining the method and the results I obtained with it, I found there are no serious objections to be made to it, and that it gives practical results.

11. Tschirch-Erikson (1910).

"Ten g. licorice extract are dissolved in a 100 g. cold water, 100 cc. of 90 per cent. alcohol are added with stirring, and the mixture warmed on the water bath for half an hour. It is then filtered, and washed with 50 cc. hot alcohol. The alcohol is removed from the filtrate on the water bath, and the volume made up to 200 cc. with distilled water in a volumetric flask.

Glycyrrhizin: 40 cc. of this solution are taken out with a pipette, and 25 per cent. sulphuric acid is added as long as a precipitate forms. After standing two to three hours it is filtered through a small filter, and washed with 5 per cent. sulphuric. The filter with the residue is heated for a quarter of an hour on a water bath, in a small porcelain dish, with 50 cc. 90 per cent. alcohol. It is then filtered and 30 cc. water added. After driving off the alcohol, another 30 cc. of water and then 25 per cent. sulphuric acid are added until the glycyrrhizin is precipitated. After standing for one hour, the liquid is filtered through a small filter, and the latter treated with 5 per cent. cold alkali. After solution has occurred, it is filtered at once into a potash-glass flask, fitted with a reflux tube, and the filter is washed out with 100 cc. water. 120 cc. Fehling solution are then added and boiled for 15 hours. The precipitated Cu_2O is determined according to Allihn, and the glucose number found is calculated to glycyrrhizic acid according to the equation:

$$360 : 896 = \text{quantity of glucose} : X.$$"

The method of Tschirch-Erikson is of great significance. It points out an entirely new way to a complete assay of licorice root and extract. In checking up this method I shall not adhere strictly to the title of my subject, but shall also examine Erikson's proposal for the determination of sugars. I believe this is all the more necessary, since as can be easily seen, the determination of sugars is difficult to separate from that of glycyrrhizin in this method for licorice

extract, and in the case of root, cannot be separated from it at all. If I take a long time over this work, this is done because at the time it was published, it was taken up in all the journals, including the foreign ones, and was praised by them. Further, a detailed control of the method does not appear to have been attempted by them. But above all, because the name of the author appears to guarantee that Tschirch's method could perhaps be accepted without such a control. The hydrolysis of glycyrrhizic acid appears to have been finally explained and established by formulas by Tschirch and his pupils.[1] By the hydrolysis with acids or alkalis, there is formed from glycyrrhizic acid, glycyrrhetic acid and glucuronic acid.

I here quote Erikson word for word, "As an aldehyde, glucuronic acid reduces Fehling solution, and if it is possible to decompose glycyrrhizic acid quantitatively into its components, a process based on this reduction must lead easily to a quantitative determination." "On the reducing capacity of the glucuronic acid, split off by hydrolysis, Tschirch has based his method for the determination of glycyrrhizin. And since both glucose and saccharose also reduce Fehling solution, but under different conditions, so must the three most important ingredients of licorice root (and Erikson also arrived at this conclusion), be capable of quantitative determination through their behavior towards this reagent."

The method stands or falls by the answer to the question: Can glycyrrhizic acid be determined quantitatively by hydrolysis by means of Fehling solution? Unfortunately I must definitely answer this question in the negative. Although the proof of this statement would prove the inadequacy of the method, I wish to enter into the whole procedure of the method, because it contains, both theoretically and practically, a good deal which is open to controversy.

[TRANSLATOR'S NOTE.—Linz then proceeds to the fact that an exact quantity of sulphuric acid is not specified, particularly in washing with 5 per cent. sulphuric acid. He found that heating the alcohol-sulphuric acid solution for a quarter of an hour carbonized the solution, and mentions a whole series of other manipulative difficulties. He thinks an actual oversight occurs at one place in Tschirch's method, and that Tschirch intends potash to be used, but omits to say

[1] *Archiv d. Pharm.*, 245, 97; 246, 545.

so. He further objects to Erikson precipitating the glycyrrhizin present in 2 g. licorice, from as much as 60 cc. of water, as this entails a serious loss through solubility. Linz claims that the question: Is glycyrrhizin quantitatively decomposed by hydrolysis? is as yet unsolved.

Linz then conclusively proves that Tschirch's method of hydrolysis with Fehling solution does not work.

After	4	hrs.	heating	Linz	obtained	0.0388 CuO = 0.054 g.	glycyrrhizin.
"	8	"	"	"	"	0.1078 CuO = 0.109 g.	"
"	12	"	"	"	"	0.2941 CuO = 0.302 g.	"
"	15	"	"	"	"	0.3041 CuO = 0.312 g.	"

When Linz makes a blank experiment, without any glycyrrhizin present, he obtains a large quantity of red cuprous oxide after two hours' boiling, which increases as the boiling is continued.

Linz therefore concludes "The decomposition of the alkali and copper tartrate, by strong heating, is very appreciable, and makes its use in the method given by Tschirch impossible. Thereby Tschirch's proposal to determine glycyrrhizin quantitatively by hydrolysis with Fehling solution falls to the ground."

Linz then shows that the self-reduction of Fehling solution has already been known in the literature, that it must be serious in 15 hours boiling, that the degree of alkalinity and the solution volume also affect the action of Fehling solution, and that there is a tendency to oxidation as well as reduction during 15 hours boiling. (P. A. H.)]

Linz concludes:

"I will summarize my objection to Tschirch's idea and to Erikson's procedure as follows:

"The proof that the hydrolysis of glycyrrhizin runs quantitatively is not attempted, and is not established.

"On the contrary, I have proved that a quantitative hydrolysis with Fehling solution cannot be carried out, because the copper or cuprous oxide weighed is derived in large part from self-reduction of the Fehling solution.

"Before the actual process of hydrolysis begins, appreciable quantities are lost, of the substance to be determined.

"The end point of the hydrolysis cannot be sharply established."

The Tschirch-Erikson Sugar Determination.

[TRANSLATOR'S NOTE.—Linz goes on to show that the determination of glucose, by allowing the filtrate from the glycyrrhizin to stand overnight in the cold with Fehling solution, is quite inaccurate, Erikson speaking of carrying out this method "according to Allihn," but not following Allihn at all as to method. Erikson does not attempt to prove the accuracy of this proposed new method, and she would have failed had she attempted it. The impossibility of the Tschirch-Erikson method is so evident, that the translator considers it unnecessary to enter into the full details of Linz's discussion. (P. A. H.)]

Linz summarizes as follows:

"The experimental method of Erikson cannot be used because it does not give correct results for the glucose content of licorice extract. Erikson has not attempted to test her glucose determination on pure grape sugar. Such a test would have convinced her of the inaccuracy of her method. She also takes no account of the peculiarity of Fehling solution to dissolve the separated cuprous oxide by oxidation."

[TRANSLATOR'S NOTE.—Linz goes on to prove that the method given for saccharose (filtrate from glucose determination, boiled three minutes with more Fehling solution) is also quite incorrect. He shows that saccharose needs preliminary inversion. Also that Erikson did not test the method on pure cane sugar, which, as expected, gave Linz a negative result.

It is unnecessary to enter into Linz experimental details which undoubtedly refute the Tschirch-Erikson method. (P. A. H.)]

Linz says "In summarizing this part of Tschirch's method, as carried out by Erikson, I cannot avoid accusing the latter of proposing a new method, without having beforehand, by suitable testing, convinced herself of its accuracy. . . . Not only the glycyrrhizin determination, but also that of the individual sugars cannot give accurate results. This is not due alone to the practical work of Erikson. Tschirch's method itself unfortunately cannot be used quantitatively."

12. Guignard (1912).

"Five g. licorice are dissolved to 500 cc. with water. To 125 cc. of this solution in a half liter beaker, there is added in a thin stream, 250 cc. 95 per cent. alcohol. After standing 24 hours, and filtering,

300 cc. of the filtrate, corresponding to 1 g. of the licorice extract, is evaporated to a syrup on the water bath. In a control experiment, it is determined whether in the solution of this extract in 5 g. of water, gum is precipitated by Telle's method. If this does not occur, the solution in 5 cc. of water is treated, after cooling, with 1 cc. sulphuric acid (diluted with the same quantity of water) and allowed to stand. It is then decanted, washed three times with 2 cc. portions of water, the residue dissolved in ammonia, evaporated, and weighed to constancy."

Guignard by his method saves the troublesome time-consuming filtration. Whether accurate results are obtainable by his method seems to me to be doubtful. Theoretically I consider this to be impossible. Guignard makes up to 500 cc., pipettes out 125 cc., then adds 250 cc. alcohol; 300 cc. are then to be measured exactly. This contains the alcohol-soluble material of 1 g. licorice. But this is only the case when one works really exactly and always uses pipettes. I call attention here to the contraction in volume of an alcohol-water mixture, as well as to loss of liquid by evaporation of the alcohol during 24 hours standing. Even careful covering can hardly prevent this evaporation.

[TRANSLATOR'S NOTE.—Linz considers that the test for gums according to Telle is superfluous. He also considers the conditions of washing by decantation unsatisfactory, and that ammonium sulphate will be present in the product weighed. He objects to the fact that less than a decigram of ammonium glycyrrhizinate is weighed. This results in large inaccuracies. Linz concludes "I cannot therefore agree with the author's conclusion 'the method proposed by us, seems to give results nearest to the truth'." (P. A. H.)]

13. Gadais I.

"In a 300 cc. beaker graduated at 50 cc., 5 g. licorice extract are dissolved in 50 cc. of boiling water, and stirred until disintegration is complete. After cooling, make up to the 50 cc. mark; 100 cc. of 95 per cent. alcohol are then added with stirring, and then allowed to stand 24 hours, covered. The liquid is poured into an evaporating dish, and when the precipitate begins to go over, it is poured on to a filter. The beaker, filter and precipitate, are washed with three portions of 15 cc. each, of dilute alcohol (two of alcohol to one of water) and the wash waters are also received in the dish. The con-

tents of the dish are evaporated to 25 cc. on the water bath. After cooling, transfer to a tared 100 cc. beaker graduated at 50 cc. Wash out the dish with water and bring the volume exactly to 50 cc. Then add 5 cc. of water which contains 1.8 cc. of 22° Be. hydrochloric acid. After stirring thoroughly, allow to stand 12 hours, so that the precipitate sticks on the bottom of the beaker. Pour off the supernatant liquid carefully, and wash the precipitate and beaker with three 10 cc. portions of water at 2° C. Add 0.5 cc. of ammonia (22° Be., d = 0.922) and dry to constant weight at 100°. The weight obtained, multiplied by 20, gives the percentage of glycyrrhizin, determined as the ammonium salt."

This method compares advantageously with many others on account of its exact detailed instructions. The amount of hydrochloric acid prescribed, (I prepared it exactly 22° Be. corresponding to a 34.4 per cent. HCl., and having a Sp. Gr. of 1.171) is sufficient for the precipitation. A further addition of acid did not precipitate any more glycyrrhizin. According to my experience, it is more desirable, after precipitating, to allow to stand 24 hours instead of 12, particularly when hydrochloric acid is used. Gadais seeks to achieve a purification of the precipitated acid, by decantation with three 10 cc. portions of water at 2°. I do not believe that the total hydrochloric acid is washed out by this means. Since the ammonium glycyrrhizinate, after drying, shows Beilstein's chlorine reaction, it must contain ammonium chloride weighed as ammonium glycyrrhizinate. The wash waters, when evaporated, give only a very slight precipitate with sulphuric acid, which is to be ascribed to the slight solubility of glycyrrhizic acid in cold water, and also to the fact that the water only acts on the surface of the acid for a short time. From 5 g. licorice I obtained 0.454, 0.459, 0.469, 0.476 g. which corresponds to 9.1-9.5 per cent. ammonium glycyrrhizinate. As the loss, I figured 1.4-1.6 per cent. The insoluble matter was 44 per cent.

This method is well worked out, being especially exhaustive in the instructions given. It gives practical results, except for the unavoidable errors connected with every glycyrrhizin determination.

14. Gadais II.

"Ten g. licorice extract are dissolved in 100 cc. water in a vessel graduated at 100 cc. and 301 cc. After disintegration of the licorice and cooling, water is added up to the 100 cc. mark; 170 cc.

95 per cent. alcohol are then added with stirring, and then more alcohol up to the 301 mark. After thorough shaking, the contents of the flask are transferred to a conical flask, which is stoppered up, and the gums, etc. are allowed to settle for 2 hours; the clear liquid is then poured off into a vessel graduated at 150 cc. When the precipitate begins to pass over, it is filtered through a fluted filter of 19 cm. diameter, until 150 cc. filtrate is obtained. The filtrate is transferred to an evaporating dish and evaporated to 25 cc.

"The further procedure is the same as for the first method."

[TRANSLATOR'S NOTE.—Linz points out that this method is intended for rapid analysis, and saves 24 hours standing. Linz concludes that this more rapid method gives results, which hardly differ from Gadais 1. (P. A. H.)]

15. Trubeck (1900).

"Two g. licorice are dissolved in 5 cc. water, starch and gums precipitated with 20 cc. 96 per cent. alcohol, and the residue filtered and washed with dilute alcohol (4 alcohol to 1 water) until the filtrate is colorless. The filtrate is evaporated to about 1.5 cc., the residue is dissolved in 2 cc. glacial acetic acid, and 30 cc. absolute alcohol are added with shaking. After standing to settle the precipitate, filter through a tared filter, wash with absolute alcohol until neutral, dry three hours at a 105°, and weigh. The precipitate does not consist of glycyrrhizin only, but also contains alkalis."

[TRANSLATOR'S NOTE.—Linz points out that glycyrrhizin compounds are probably precipitated with starch and gums, by the use of so much strong alcohol. Linz also points out a number of other objections, which render this method without value, and he also states that it is not possible to improve it, with a view to making it workable. (P. A. H.)]

16. Schröder (1884).

[TRANSLATOR'S NOTE.—This method uses repeated precipitation with sulphuric acid, but gives absolutely no details as to quantities. Linz points out that the losses from repeated precipitations are obviously very great, and that the method has only historical interest. (P. A. H.)]

17. Müntzer (1888).

"Ten g. licorice extract are extracted for two hours in a flask with 190 g. of water and 10 g. ammonia. After allowing to settle, pour the liquid on a filter, wash the flask, and filter with small quantities of the extraction liquid, totaling 100 cc. The filtrate is acidified with dilute sulphuric acid. After standing one hour, the precipitate is filtered, and washed with water. It is again dissolved in 5 per cent. ammonia, and again precipitated. After standing one hour it is filtered through a dry, tared filter, washed with pure water, dried at 100°, and weighed."

[TRANSLATOR'S NOTE.—Linz points out the great loss of glycyrrhizic acid, resulting from the large volume of wash water used. The re-precipitation also causes much loss of glycyrrhizin. Linz determined the losses to be nearly as much as the glycyrrhizin actually weighed. Linz rightly states that the method cannot be used as a quantitative determination. (P. A. H.)]

18. Morpurgo.

[TRANSLATOR'S NOTE.—This method makes use of ammonium oxalate, presumably to decompose calcium glycyrrhizinate. Linz did not check up this method, and it cannot be considered of any special value. (P. A. H.)]

19. Dutch Pharmacopœia (1905).

"Five g. licorice extract are dissolved in 50 cc. water to which 2 cc. spirits of ammonia have been added. The volume is made up to 100 cc. with water. Sixty cc. of this is filtered, and evaporated to 15 cc. After cooling, 5 cc. dilute hydrochloric acid are added. After settling, the precipitate is brought onto a filter, washed with 5 cc. water, and dissolved on the filter with ammonia. The solution is evaporated, dried in a desiccator, and weighed. The dry residue should weigh at least 0.24 g., corresponding to a minimum of 8 per cent. glycyrrhizin."

[TRANSLATOR'S NOTE.—Linz objects to the extreme difficulty of filtering the original ammoniacal solution, which objection he justly raises to all those methods which do not precipitate gums with alcohol. Linz points out that the filtration and washing of the precipitated glycyrrhizin is entirely unsatisfactory. He considers

the acid weighed, very impure. It gives a strong chlorine reaction and consequently, give results which are too high. Linz rejects this method. (P. A. H.)]

20. Kinzey (1898).

A mixture of 40 cc. of ammonia, 240 cc. of alchhol, and water up to 1000 cc. is used as an extraction liquid.

[TRANSLATOR'S NOTE.—Linz justly condemns this method on several grounds. The glycyrrhizin is precipitated from much too large a volume, and it is precipiated by sulphuric acid in the presence of alcohol, whereas the alcohol should obviously be removed. The use of dilute acetic acid to wash the precipitated glycyrrhizin, results in further loss, and the quantity of licorice used results in much too small a quantity of glycyrrhizın being weigned for an accurate method.

Linz concludes that Kinzey's method is without value. (P. A. H.)]

21. Anselmino-Gilg (1911).

[TRANSLATOR'S NOTE.—This method is adapted from that of Kremel, some of whose missing instructions are here supplied. The original solution is made with ammoniacal water. Linz points out that a considerable loss of glycyrrhizin results from washing with 50 cc. water. Linz further states "for fundamental reasons stated in the introduction I object to the use of an ammoniacal extract. From the large quantity of water used in washing, considerable errors result. There are no other objections to this method." (P. A. H.)]

22. Stoeder (1901).

[TRANSLATOR'S NOTE.—This method also uses ammoniacal water to dissolve the original licorice extract. Linz points out that the quantity of wash-water prescribed is far short of that necessary, resulting in ammonium chloride being mixed in with the glycyrrhizin weighed. The glycyrrhizin is also very ımpure on account of the original ammoniacal extraction. (P. A. H.)]

23. Telle (1911).

"2.5 g. licorice extract are dissolved in 20 cc. of water in a centrifuge tube, and whirled for fifteen minutes. The clear liquid is poured off, the residue is mixed with ammoniacal water (10 cc. of

1 : 9) and again whirled for fifteen minutes. The liquid is poured off again, and the residue washed by centrifuging for ten minutes with 10 cc. water. If the liquid poured off is still colored, the washing is repeated. The aqueous and ammoniacal extracts are united with the washings, and evaporated. The thick extract is transferred to a centrifuge tube, and water added to a 10 cc. mark; 25 cc. of alcohol are then added. Gums and albumens are precipitated. After centrifuging fifteen minutes, the alcoholic liquid is poured off and evaporated. The thick extract is dissolved to 50 cc. with warm water, and after cooling, 1 cc. hydrochloric acid is added with shaking. After standing twenty-four hours, the liquid is poured off, and the residue washed with small portions, totaling 25 cc., of water saturated with ether. The filtration is made carefully, so as to bring as little as possible of the precipitate on to the filter. The residue in the tube is dissolved in 1 cc. of ammonia, and poured through the same filter. The tube and filter are washed until colorless, with ammonia water (1 : 9), and the filtrate evaporated to constant weight."

[TRANSLATOR'S NOTE.—A summary of the criticisms of Linz for this method is as follows: The abstracts in the German journals contain errors so that the original had to be consulted for checking up the method. Linz finds a second washing of the ammoniacal residue necessary. He calls attention to the fact that 50 cc. is too large a volume from which to precipitate the glycyrrhizin. He approves the use of water saturated with ether, but thinks 25 cc. too much. He also approves of the time saved by the centrifuge. Linz obtained by this method 8.97-9.27 per cent. ammonium glycyrrhizinate, with losses determined at 1.6-1.82 per cent. Linz finds this method for glycyrrhizin unnecessarily inconvenient, and does not see how to improve it in this respect. (P. A. H.)]

24. Durier (1913).

[TRANSLATOR'S NOTE.—This method uses ammoniacal alcohol on the original licorice extract. It uses the centrifuge, and precipitates from 50 cc., with hydrochloric acid, washing the precipitate with 5 portions of 5 cc. water. A correction of 0.023 g. for losses in washing, is made when 2 g. of original licorice is used.

Linz objects to the use of ammoniacal alcohol, to the large volume of 50 cc. for precipitating glycyrrhizin, to adding 1 cc. of ammonia before such precipitation, and to the use of the prescribed quan-

tity of water for washing. He shows that the Durier solubility-correction is incorrect, and he finds the loss to be 3.3 per cent. Linz says the method cannot be recommended, the results being decidedly too low as the losses are very high. (P. A. H.)]

25. Haffner (1899).

"Ten g. licorice extract are treated with about 200 cc. 95 per cent. alcohol; 25 cc. normal sulphuric acid are then added, and allowed to stand several hours with shaking. Filter, and wash with strong alcohol, as long as the filtrate is colored. Treat the filtrate with a 100 cc. of water, and with ammonia, until weakly alkaline. Remove alcohol on water bath, bring the residue to a 100 cc. and acidify with dilute sulphuric acid. Settle for an hour, filter, wash the residue with 2-3 per cent. sulphuric acid, until the washings are colorless. Dry the filter in a sulphuric acid vacuum desiccator, extract with acetone two or three times on the water bath until the last extract is colorless. To the acetone extract add a suspension of barium carbonate in water and remove the acetone on the water bath, using a tall beaker. The residue is extracted with portions of hot water, totalling 200 cc. The solution of barium glycyrrhizinate, after cooling, is filtered into a 500 cc. volumetric flask which is filled to the mark.

"The total solids in 100 cc. of the above solution are determined. The glycyrrhizic acid is calculated from the barium glycyrrhizinate. The latter is evaporated with sulphuric acid, and ignited to constant weight. From the barium sulphate weighed, the barium glycyrrhizinate in the total solids residue is calculated. The higher the barium content, the purer the weighed product."

Haffner's method brings forward a number of new ideas. Above all, the alcoholic-sulphuric extraction is new and good. I have spoken of it in detail in the introduction. The purification of the precipitated acid with acetone, is also new, as is especially the determination of glycyrrhizin as a barium salt.

[TRANSLATOR'S NOTE.—Linz goes on to point out that the large amount of alcohol necessary to wash the original insoluble matter, and the difficulty of washing the precipitated acid until colorless with 2-3 per cent. sulphuric acid, involves some loss. Linz is unable to get a sharp acetone separation. Linz makes an experiment to show that, by using alcohol, instead of acetone, he obtains a greater

purification, as well as a more convenient manipulation, since the acetone causes violent bumping, when evaporated from the tall beaker. Zetsche in criticising Haffner, proposes to avoid this bumping by using barium hydrate and a large porcelain dish.

Linz points out that the clumsy and inconvenient method of Haffner will not justify itself unless his statement had been correct, *i. e.*, "The higher the barium content, the purer the glycyrrhizic acid," and Linz clearly shows experimentally, that the statement does not hold, and that other constituents of licorice, those of acid nature, will form barium salts, and so increase the result. Zetsche objects to Haffner's method of obtaining barium sulphate, and also believes that 500 cc. water are not enough to dissolve the barium glycyrrhizinate, but Linz does not support either of these objections of Zetsche. (P. A. H.)]

Linz summarizes his views of Haffner's method as follows:

"1. The method is more troublesome than others.

"2. The values are lower than one would expect, from the results of other methods.

"3. Values obtained agree well with one another.

"4. I cannot prove direct sources of error in Haffner's method, but the low yield can only be explained by the occurrence of losses during the course of the analysis.

"5. The opinion which Haffner has emphasized that the barium content of the barium glycyrrhizinate weighed is a key to the purity of the acid is probably not true. At any rate it can be experimentally proved that it is not always true."

26. Cederberg (1907).

"Ten g. roughly powdered licorice extract are covered with 200 cc. 95 per cent. alcohol in an Erlenmeyer flask, then 25 cc. normal sulphuric added, and digested for several hours with frequent shaking. Filter, and wash with 100 cc. of hot alcohol. To the filtrate, add half its volume of water and render ammoniacal. Remove the alcohol by evaporation to less than 100 cc. Make up to 100 cc. and add an equal volume of 20 per cent. sulphuric acid. Collect the precipitated glycyrrhizin on a filter, wash with 50 cc. 10 per cent. sulphuric acid, and dissolve on the water bath in 95 per cent. alcohol. After washing with 50 cc. warm alcohol, the filtrate is treated with half its

volume of water, saturated with potassium hydrate, and made up to 500 cc. in a volumetric flask.

"One hundred cc. of the solution are evaporated in a weighed dish, and dried to constant weight at a 110°. Another 100 cc. are precipitated hot with barium chloride, filtered, and washed on a tared filter, dried at a 110°, and weighed.

"The amount of glycyrrhizin in 2 g. licorice extract is obtained by calculating the barium sulphate to potassium sulphate, and subtracting that amount from the quantity representing the mixture of neutral potassium glycyrrhizinate and potassium sulphate, and further subtraction of 11.58 per cent. for the amount of potassium in the salt."

[TRANSLATOR'S NOTE.—Linz shows that pieces of "roughly powdered licorice extract" are not penetrated by the sulphuric-alcohol mixture even after one and a half days, or even after several hours warming. In spite of using finely powdered material, he obtained 59-60 per cent. insoluble residue. Linz further shows that considerable loss results from precipitating glycyrrhizin from the excessive volume.

Linz demonstrates that Cederberg's barium chloride precipitation is open to serious objection, and is not practical, unless modified. With the necessary modification, he obtained the results 11.59, 11.75, 11.9 per cent. glycyrrhizic acid. (P. A. H.)]

Linz continues:

"Cederberg's method is undoubtedly interesting and original. But his method requires a long time, and weighings which are not simple, and also uses more than half a liter of alcohol for every glycyrrhizin determination. The values obtained are higher than others, because he includes in the weight much impurity. In addition to this, the losses of glycyrrhizin are high, but I have been unable to establish their amount, even approximately. . . .

"Taking into account the fact that in spite of a roundabout analytical method, one obtains results which are too high on account of gross impurity of the weighed acid, and further that the losses of glycyrrhizic acid are not inconsiderable, one cannot hail Cederberg's method in the form given, as an improvement."

27. Schmidt (Haffner), (1911).

[TRANSLATOR'S NOTE.—Schmidt uses Haffner's mixture of alcohol-sulphuric acid in treating the original powdered licorice extract, but instead of going through the acetone treatment, and obtaining the barium salt, he weighs the precipitated glycyrrhizin directly on a tared filter after washing with dilute sulphuric and then a little water.

Linz comments on the absence of exact instructions as to quantities of sulphuric acid with which to precipitate and to wash. He obtained 9.1 and 9.4 per cent. glycyrrhizin, and appears to have little objection to the method. (P. A. H.)]

CONCLUSIONS FROM MY RESEARCHES.

As the result of my researches, I have made a table in Appendix C which summarizes the methods, and which is intended to serve in deciding the question as to which is the best method.

A large number of the methods are summarily rejected. I so classify all those determinations, which, through false analytical procedure, give results which are certainly wrong—too high or too low. Then I also reject such methods which, through inexact or erroneous directions, give results which are unreliable, and not suitable for direct comparison.

In the first class belong the method of Capin, Erikson, Trubeck, the Dutch and French Pharmacopœias.

In the second class belong Rump, Helfenberg, Kremel, Diehl, Guignard, Py, Anselmino-Gilg, Stoeder, Schröder, Müntzer, Kinzey, Durier, Schmidt-Haffner. In this second class I have placed all those methods which do not and cannot give directly reliable results when carried out exactly as the directions call for. In so doing, however, the analytical procedure on which the method is based is not in itself designated as impracticable, but only the execution of the method, so that the particular methods in this class yield practical results, after certain modifications.

Less practical are the methods of Guignard, Gadais II, Telle and Cederberg, for reasons which I have given in discussing the individual methods.

Practical results are given by the three almost identical methods of Parry, Evans' Sons, Lesher & Webb, and Houseman, and perhaps also Gadais I.

It is true that none of these methods attempt to achieve a high degree of purity of the glycyrrhizic acid weighed. Particularly in the case of Parry and Evans' Sons, is little attention given to the washing of the glycyrrhizic acid.

According to my experience with the individual methods, none of them completely fulfills the requirements which are demanded. One must, of course, leave out of account small errors which are unavoidable in a glycyrrhizin determination.

Experiments to Work Out a Glycyrrhizin Determination.

In the hope of obtaining a purer form of glycyrrhizic acid, I have treated the precipitated, impure acid with all the organic solvents available to me. All such attempts, including those with salts of glycyrrhizin, proved to be quite impracticable. The converse method of retaining the acid and dissolving the impurities in a solvent, did not work out. I further attempted to find a glycyrrhizin salt, more particularly of a metal, which I could purify, and then decompose again, perhaps with hydrogen sulphide. These attempts were also unsuccessful.

The copper salt, of a fine green color, seemed to promise success, but after being thoroughly washed, and decomposed with hydrogen sulphide, a glycyrrhizin was obtained which was just as dirty and unattractive as before. It seems therefore that the impurities are themselves acid in character, and are in every case attached to the metal.

All these experiments, which consumed much time, proved to be impractical. It therefore seems as though one can only proceed along the lines already laid down. I believe that the object is best obtained if one starts out from the method of Diehl.

The method which I would here propose, is of course not exact. I have often emphasized, that in my opinion, accuracy is not to be achieved. It gives good results, however, inasmuch as it corrects some of Diehl's mistakes, and makes use of the experience, which has meanwhile been gained. Above all it previously purifies the glycyrrhizic acid weighed.

My Own Method.

Five g. licorice are treated with 50 g. distilled water with frequent shaking and slight warming, until disintegrated, and after cooling, 100 cc. 95 per cent. alcohol are added. After standing six

hours, the mixture is filtered and the insoluble matter on the filter is washed with successive small quantities of 60 per cent. alcohol, totaling 50 cc. The filtrate and washings are freed from alcohol on the water bath, and evaporated to about 30 cc. The residue is transferred to an Erlenmeyer flask, graduated at 50 cc., the dish washed out with water, and the contents of the flask made up to the mark; 5 cc. dilute sulphuric acid are added with stirring, and the mixture allowed to stand one hour at room temperature, followed by 24 hours on ice. The acid sticking to the bottom is brought quantitatively on to a filter, and washed carefully with 15 cc. of 2 per cent. sulphuric acid. The filter is then washed with 15 cc. ice cold water, saturated with ether. The filter is dried over sulphuric acid at room temperature in a vacuum desiccator, and then extracted five times successively, with 20, 20, 10, 10, 10 cc. of hot 95 per cent. alcohol in the Erlenmeyer flask. The solutions are filtered into a tared dish, the filter washed with 15 cc. hot alcohol, and the filtrate evaporated on the water bath, and the residue dried at a 100° to constant weight.

The liquid poured off from the precipitate is united with the wash waters and after neutralizing with ammonia, is evaporated to a thick syrup. This is transferred to a glass cylinder, and the evaporating dish is washed out, making up to a mark at 18 cc.; 2 cc. dilute sulphuric are added with shaking. It is allowed to stand one hour at room temperature, and 24 hours on ice. The supernatant liquid is poured off, the precipitate brought on a filter, and washed with 5 cc. 2 per cent. sulphuric acid, and 10 cc. ice-cold ether-water, drop by drop. The residue, dried in the vacuum desiccator, over sulphuric acid, is extracted with 10, 10, 5 cc. hot 95 per cent. alcohol, the extract filtered into a tared dish, the filter washed with 5 cc. hot alcohol, and the filtrate evaporated on the water bath. The amount obtained after drying is added to the portion obtained above. The sum of the two represents the total glycyrrhizic acid in 5 g. licorice extract.

In this method I have taken particular account of practical requirements. In my opinion, it is going too far to require that the insoluble residue shall be washed until colorless. This is extremely difficult. In one experiment I washed the filter with 50 cc., and since the filtrate was still colored, a further 100 cc. was poured through. These 100 cc., however, upon evaporation gave only a very slight film of light yellow color, which can have no practical influence on the result.

For the precipitation I dissolved the extract from 5 g. licorice in 50 g. water. I consider this proportion, 1 + 9, the best. If the solution is more dilute there is danger of greater losses through the solubility in more water. If one goes under this proportion, one must necessarily use more liquid for washing, which again entails more loss. I have used the purification recommended by Diehl, because it gives good results, as I have already discussed under Haffner's method. In carrying out Diehl's method, I have already mentioned that his ammonium salt is notably of lighter color than that of the impure acid. The difference is easy to see. It is also important to note that this purification does not seem to be accompanied by any loss, as happens with Haffner's method. With the quantity of alcohol I use, one does not obtain at the end of the extraction of the acid, a perfectly colorless extract. But I am satisfied that 70 cc. alcohol is sufficient, after having convinced myself that further quantities of liquid leave, after evaporation, a hardly weighable residue. This condition is accounted for, by the extraordinary coloring power of the impurities of the glycyrhizic acid. By evaporating the alcoholic solution, and determining the glycyrrhizic acid as such, and not as a salt, I avoid the errors of many of the other methods, which convert the sulphuric or hydrochloric acid which is not washed out into ammonium salt, and thereby obtain more or less considerable losses.

I consider the determination of the glycyrrhizin in the evaporated alcoholic solution more exact and convenient than when it is weighed in a weighing bottle on a filter paper. The determination of the loss which I give, is based upon the explanation given in the introduction. I can draw upon the large number of experiments made in this connection. The sum of the two individual determinations gives the glycyrrhizin content of the licorice.

By several glycyrrhizin determinations carried out by my method, I obtained 9.00 + 1.11 = 10.11; 9.05 + 0.93 = 9.98; 9.31 + 0.84 = 10.15; 9.4 + 0.92 = 10.32; 9.5 + 0.91 = 10.53 per cent.

[NOTE.—This is a misprint for 10.41 per cent. (P. A. H.)]

The method proposed by me takes considerably more time than the majority of the methods hitherto published. I attain, however, by my method, relatively high values, with a considerably higher degree of purity, and have only trifling losses of glycyrrhizic acid.

Glycyrrhizic Acid Determination in Licorice Root.

In the introduction to this work I made mention of the numerous attempts to extract the glycyrrhizic acid from licorice root. There, I gave a short description of such proposals. Those researches are only qualitative in character, and make no claim of giving quantitative results. None of them are suitable for a glycyrrhizin determination, even after changing the directions. The only methods that need be mentioned here, are those of Houseman and Erikson. This small number appears, at first sight, surprising, when compared with the 27 methods available to me for glycyrrhizin determination in licorice extract. If one remembers, however, that the glycyrrhizin content in the root is definite and cannot be diminished by any outside influence, such as adulteration.

[Translator's Note.—The *powdered* root can surely be adulterated] and then remembers, on the other hand, that licorice extract is very largely adulterated, then this difference does not appear so surprising. Then also the experimental difficulties in the case of licorice root are still more unfavorable than in the case of licorice extract and this has deterred workers from being more active with this question.

In the literature, I find, in several places, statements about the glycyrrhizin content of the root:

Tschirch-Belander	3.0 per cent.
Sestini	3.3 " "
Cederberg	3.0 " "
Möller-Flückiger	7.5 " "
Realenzyklopädie	2.5 " "
Tschirch, Handbuch	5.3-7 per cent.
Houseman	5.9-13.24 per cent.

With the exception of Erikson and Houseman, none of them state how they arrive at these values. They appear to be more or less a matter of estimating. In earlier publications Tschirch (*Archiv der Pharmazie,* Vol. 245) states that estimates over 3 per cent. are much too high, yet in his Handbook he himself gives 5.3-7 per cent. The values which Houseman gives, reaching as high as 13.24, must of themselves arouse mistrust.

[Translator's Note.—This high value was only in one sample out of ten. The figure given was correct. (P. A. H.)]

The Quantitative Testing of the Published Methods.

1. tschirch-erikson (1910).

The method given by Tschirch-Erikson for the simultaneous determination of glycyrrhizin and of sugars in licorice root, is fundamentally the same as that already mentioned for licorice extract. In carrying it out practically, however, there are some differences. In addition to the actual method for licorice root, I wish to discuss at this place the experiments which Erikson used, from which to establish her analytical procedure. The basic thought of the method proposed by Tschirsch, I have already discussed under the methods for licorice extract, so that I can assume at this point that it is known.

The procedure for examining licorice root according to Erikson is as follows:

"I. First the glucose is determined by 15 hours standing with Fehling solution in the cold.

"II. After filtering off the precipitated cuprous oxide, the saccharose is determined by short boiling with Fehling solution, and finally,

"III. The glucuronic acid split off from the glycyrrhizin is determined in the filtrate by long boiling with Fehling solution."

This differs from the method proposed for licorice extract. In the latter case, the glycyrrhizin is first separated with sulphuric acid, and the filtrate, containing the sugars, is treated separately. In the case of the root, the order is changed, first the glucose, then saccharose, and finally the glycyrrhizic acid being determined. The reason for this change is not clear. Erikson says that "The method has been changed by conditions imposed by the material." She does not state what grounds lead to this change.

Her research is divided into four sections:

1. Preparation of the root extract.
2. Determination of glucose.
3. Determination of glucoses present as saccharose.
4. Determination of the glycyrrhizic acid.

1. Preparation of the Extract.

On the basis of three experimental series, Erikson proposed the following method for the preparation of the extract of the root.

"Ten g. of powdered licorice root are mixed with an equal volume of powdered glass, moistened with a little water, and allowed to

stand several hours. The mixture is then transferred to a percolator, and 50 cc. of water added, which for every 100 cc. contains three to four drops of alkali, to combine with the glycyrrhizic acid, and convert it to a soluble form. The mixture stands overnight. The liquid is then allowed to drop at 12-15 drops to the minute, adding fresh alkaline water all the time. The extraction is continued until the percolate is tasteless. The extraction takes place at 15°. At a higher temperature Erikson adds a few drops of chloroform to prevent fermentation, and the formation of mold. The extraction liquid is received in a sterile flask and made up to 200 cc."

Houseman has objected to this method, that the long standing will cause losses by enzyme action, and this objection is not without justice, because the extraction to exhaustion takes over two days. I have often observed, that aqueous extracts of licorice root decompose extraordinarily easily. I notice this in extracting large quantities of licorice root to make chemically pure glycyrrhizic acid. It would, however, be difficult to find a way of avoiding these losses.

"For the analysis, pipette off 40 cc. of the extract, add 44 cc. 90 per cent. alcohol and heat in a beaker on the water bath. The gummy substances are precipitated by the alcohol. This operation and the subsequent removal of the alcohol must be conducted as rapidly as possible, in order that the sugars may not be decomposed. After the alcohol has been completely removed, filter through a small filter, and wash thoroughly with water, uniting the washings with the filtrate."

Attention must here be called to a remarkable difference between the directions for root and for extract. Erikson says for root, that the heating and evaporation must take place as rapidly as possible, in order to avoid losses of sugar. On the contrary, she lets the corresponding licorice extract solution stand for half an hour on the water bath with alcohol.

2. Determination of Glucose.

[TRANSLATOR'S NOTE.—Linz points out that Erikson only makes a single experiment, on one variety of root, to establish that the maximum amount of cuprous oxide is precipitated in 15 hours in the cold. It is remarkable that, having considered this time for maximum preciptation established, she does not use it anyway. Linz further shows that although Erikson admits that this Fehling reduc-

tion is highly sensitive to small changes in temperature, she does not specify or control such temperature accurately. Linz's proof already given for extract, that Erikson's method cannot be possibly used, applies also in the case of root and further detailed criticism is superfluous. (P. A. H.)]

I summarize my criticism as follows: The Tschirch-Erikson method for glucose determination, has the same drawbacks when applied to root, as when applied to extract. The method does not consider the secondary reactions which take place with the use of Fehling solution. The method for determining the time the Fehling solution is to act, is open to objection. The instructions for the method are inexact, and take no account of the results of her own experiments. There is no doubt that the total glucose is not determined by Erikson's method.

3. Determination of Saccharose.

[TRANSLATOR'S NOTE.—Linz shows that saccharose does not reduce Fehling solution at all, by three minutes boiling, and that the method is hopeless. (P. A. H.)]

4. Determination of Glycyrrhizic Acid.

[TRANSLATOR'S NOTE.—Linz objects to the absence of exactly specified quantities of reagents and shows that a maximum precipitation of cuprous oxide in 14 hours, simply represents a condition of equilibrium, at which no further self-reduction of Fehling solution takes place.

He is right in passing the same unfavorable judgment on this method for root as he did in the case of extract. (P. A. H.)]

2. HOUSEMAN (1913).

That which makes the glycyrrhizin determination more difficult in root than in licorice extract, is the act of dissolving out the glycyrrhizic acid, quantitatively. Erikson attempts to exhaust the root by percolation. There are objections to this method, even of a purely practical kind. The starch in the root swells up so much, and sometimes gives such a thick mess that no water percolates through.

Houseman has used another method. He first of all exhausts the root with 95 per cent. alcohol, and claims that there is no glycyr-

rhizin in the extract. After having removed the resins and bitter substances by this method, he extracts with 50 per cent. alcohol, and claims that he obtains the glycyrrhizin quantitatively. In spite of this, I am not sure whether Houseman claims a quantitative yield for his method. Some parts of his research seem to speak against it. For instance, the root is only to be used after careful picking. But for quantitative methods, one should demand that not only selected pieces can be examined, but also average samples. When further, Houseman finds 0.5 per cent. glycyrrhizin in the last alcoholic extract, and considers the root thereby exhausted, without putting on a control experiment, I fail to follow him on this point.

I will now go through his method and communicate the results of my control of it.

Before use, the root is to be dried in a vacuum desiccator. The root I used contained 9.2 per cent. of moisture. After standing five days over sulphuric acid in a vacuum desiccator, the moisture content was redued to 3.8 per cent. Ten g. of this roughly powdered root was extracted four times with 100 cc. portions of 95 per cent. alcohol. I allowed each extract to stand 24 hours with frequent shaking. Houseman does not state how much alcohol is obtained each time. I evaporated the 400 cc. of extract, and obtained a considerable residue of a brown yellow color. The portion of this residue which is soluble in warm water, gave after cooling, and acidifying with sulphuric acid, a very trifling, flocculent precipitate, and therefore contained very small traces of salts of glycyrrhizin, and probably also traces of free glycyrrhizic acid. The portion of the root which had been freed from resins and bitter substances is now treated with 50 per cent. alcohol. Here again Houseman states no quantities.

I extracted six times, with 50 cc. each, of 50 per cent. alcohol (Houseman prescribes only five times). In order to establish the quantity of extract removed each time, and thereby the progressive extraction of the root, I evaporated the extract each time, in the same tared crucible. I so obtained the amount of extract from each succeeding extraction. After standing for a half a day, the extract was poured off and another 50 cc. of alcohol added. The extraction with the two strengths of alcohol thus lasted a total of seven days.

With 50 per cent. alcohol I obtained the following quantities after evaporation:

1....	9.38	9.11	10.35	
2....	7.24	6.72	6.17	
3....	4.66	4.11	3.21	
4....	1.52	2.39	1.89	
5....	0.52	0.45	0.78	
6....	0.33	0.33	0.12	and for control.
7....	0.44	1.12	0.15	
	23.69%	23.23%	22.67%	

After I had thus proved that the powdered root had been exhausted with 50 per cent. alcohol, I digested it for three hours on the water bath, with alcohol of the same strength. The evaporated filtrate gave no glycyrrhizin reaction. It really seems then that the total glycyrrhizin is removed by the cold alcoholic extraction. Houseman gives no further information as to how the extract is to be worked up. It is, however, clear that the extract, evaporated to dryness, is to be treated by the method which he gives under licorice extract. I so proceeded, and obtained in the residues given above, 6.4 per cent., 6.1 per cent. and 6.8 per cent. glycyrrhizic acid.

Houseman only reports, as I have stated above, on the progress of his own researches, in which he used 100 g. of each kind of root, and does not state the further examination of the alcoholic extract of the glycyrrhizinate. The extract from 10 g. of root, amounting to about 2.5 g., cannot well be dissolved in 10 cc. hot water. I needed 20 cc. and used accordingly twice as much alcohol. The glycyrrhizin obtained was of a light brown color and therefore considerably purer than that obtained by any other methods for licorice extract. The impurities, which give to the glycyrrhizin from the licorice extract a nearly black color, appear in the extract only through the method of manufacture. The control of Houseman's method shows its suitability. It seems to give quantitative yields of the glycyrrhizic acid, with a high degree of purity of the latter. Substituting an extraction with alcohol for percolation with water must be regarded as a considerable improvement.

It might be recommended to use absolute alcohol for the first extraction, and add a few drops of ammonia to the total quantity used for extraction, in order to fix the free glycyrrhizic acid, and make it insoluble in absolute alcohol.

APPENDIX A AND APPENDIX B.

Four closely printed pages of literature references.

APPENDIX C.

Elaborate statement covering four pages, summarizing, in tabular form, all of the conditions and results associated with the twenty-seven methods for determining glycyrrhizin in licorice extract, which the author has discussed.

P. A. HOUSEMAN.

May, 1921.
Camden, N. J.
MacAndrews & Forbes Co.,

STUDIES ON LICORICE ROOT AND LICORICE EXTRACT.

By PERCY A. HOUSEMAN, PH. D., F. I. C.

PART 3.

Previous papers on this subject by the author have appeared in this JOURNAL, December, 1912, and March, 1916. The present article is published in connection with a translation which I have made of an article by Linz (*Arch. der Pharm.*, 1916, *254*, 65 and 204), entitled "Comparative Researches on the Methods Proposed for the Estimation of Glycyrrhizin in Licorice Extract." This (abridged) translation appears in two instalments in this JOURNAL, June, 1921, and in this issue.

The article of Linz is so exhaustive that it merits detailed examination. Linz subjects to critical experimental examination, twenty-seven methods which have been proposed for the determination of glycyrrhizin in licorice extract, and two methods proposed for glycyrrhizin in root. Accepting what he considers the desirable features of the best methods put forward for licorice extract, Linz compiles a method of his own.

The present writer agrees with nearly all of the criticisms made by Linz. Linz points out that all of the analytical methods proposed weigh only a more or less crude glycyrrhizin. He rightly condemns the use of an ammoniacal solvent on the original licorice extract, and approves an aqueous solution, followed by the addition of alco-

hol, which not only removes starch and gums, but renders filtration easy on a material which is otherwise very inconvenient to manipulate. Of all of the acids proposed to precipitate glycyrrhizic acid, he finds sulphuric to be the best.

For his control work on the twenty-seven methods for the assay of licorice extract Linz has used the Baracco brand. It is rather surprising that he should have been satisfied to use a material which, as he states himself, was characterized by an extraordinary content of free copper, which he invariably found present, sometimes in pieces as long as 5 millimeters, weighing 0.062 grams. A product so crudely made hardly seems the most desirable for accurate analytical control work.

Linz then proceeds to the experimental control of the twenty-seven methods, and for one reason or another rejects all except three—those of Parry, Evans' Sons, and Houseman, and possibly Gadais. Linz states that the methods of Evans' Sons and myself are both modeled on that of Parry.

I wish at this place to emphatically contradict this statement. On the first page of my article in this JOURNAL, December, 1912, I clearly stated that Parry received his method from me and that the MacAndrews & Forbes Company had used it for more than twenty years. Parry published it without acknowledgment of its source, and has contributed nothing original to the quantitative determination of glycyrrhizin. If Evans' Sons derived their method from Parry, it is evident that the method I have given is practically the only original method which Linz accepts, from the twenty-seven proposed. Subsequent experience has caused some modifications in the method I use, which I shall discuss later.

Reply may here be made to minor criticisms which Linz makes of my method. Linz cannot understand why I specify evaporating the alcoholic solution of glycyrrhizin to dryness *in vacuo,* and assumes that I evaporate in vacuo to avoid possible decomposition of glycyrrhizin, but this is not the case. There is no danger of any decomposition of glycyrrhizin during removal of the acohol. It is simply that I find it a quick and convenient way to completely remove and recover the alcohol, the recovery being an important matter in these days. I consider it undesirable to direct that the alcohol shall be removed by "evaporating to a syrup," or "evaporating nearly to dryness" on a water bath. Such vagueness easily permits a trace of alcohol to remain, and that would prevent complete pre-

cipitation of the glycyrrhizin by sulphuric acid. A little alcohol is rather obstinately held by the syrup, and in order to be quite safe I prefer to remove the bulk of the alcohol by distillation in a round-bottomed flask from a steam bath without vacuum, and finish just to dryness under a vacuum. Under these conditions no trouble with bumping need be experienced.

Certain other criticisms of my method by Linz will be mentioned when I come to state my present method of analysis.

Linz further says: "When Houseman states in conclusion that he weighs pure glycyrrhizin, he is grossly deceiving himself." Linz must either have had access to a poor abstract, or have made a careless translation himself at this point. In my article of 1912 I am careful to state that *crude* glycyrrhizin is weighed.

Reference must here be made to the method of Tschirch-Erikson, because of the prominence of the first author, as well as on account of the originality of the method proposed. Linz has very carefully tested Tschirch's method, which seeks to determine glycyrrhizin, glucose and saccharose successively, on the basis of their reduction of Fehling's solution. Linz confirms my own published conclusions that the method proposed by Tschirch for determining glycyrrhizin and sugars in licorice extract and in root is completely unworkable.

I cannot understand how Prof. Tschirch can have given his sanction to the publication by Erikson, of a method, upon which obviously not nearly enough work was done, and which also on theoretical grounds is quite unsound.

This is particularly unfortunate, because the name of Tschirch has caused some acceptance of his method in the literature, when it would otherwise have been refuted. I find the Tschirch-Erikson method given, for example, in a new book by Henry C. Fuller, "The Chemistry and Analysis of Drugs and Medicines," 1920, page 50. My own method is given in a later chapter in the book (pp. 408-410).

Having disposed of the methods hitherto proposed for the assay of licorice extract for glycyrrhizin, Linz then considers the methods for licorice root. He considers only two methods worth discussion—that of Tschirch-Erikson, and my own. He is forced to refute the Tschirch-Erikson method for the same reasons as apply to licorice extract, and accepts my method, stating that it gives quantitative yields of glycyrrhizic acid, with a high degree of purity of

the latter. He accepts my alcoholic extraction of the root (this JOURNAL, December, 1912, p. 542) as a considerable improvement over percolation with water.

Before summarizing my experience of the last few years in the analysis of licorice root and extract, and giving what I consider to be the best method available at this time, I shall examine the method which Linz himself proposes for licorice extract.

The Linz Method for Determination of Glycyrrhizin in Licorice Extract.

This method is given on page 458 of the June issue of this JOURNAL. There are no fundamental objections to it, but it is open to certain minor criticisms, which I mention:

1. Linz precipitates starch and gums with alcohol of about 65 per cent. strength, and washes with 60 per cent. alcohol. I prefer to use 75 per cent. alcohol which completely dissolves glycyrrhizin and precipitates gums more completely. Unprecipitated gums will tend to make the glycyrrhizin figure too high.

2. Linz evaporates the alcoholic solution to 30 cc. I do not consider that all of the alcohol is sure to be removed from the remaining syrup. A trace of alcohol will make the subsequent precipitation of glycyrrhizin with sulphuric acid incomplete and yield low results. I consider the alcoholic solution should be evaporated almost or just to dryness, finishing under reduced pressure if desired.

3. Linz fails to specify strength of sulphuric acid to be used in precipitating glycyrrhizin.

4. I do not think it necessary to dry the glycyrrhizin precipitate in a vacuum desiccator before dissolving it in 95 per cent. alcohol. I was unable to dissolve it from the filter paper with the quantity of alcohol prescribed by Linz.

5. Linz precipitates a second portion of glycyrrhizin from the evaporated filtrate and washings from the first (main) portion. *This is good,* but the second portion need not be weighed separately from the first portion.

I pass now to the method which I propose.

DETERMINATION OF GLYCYRRHIZIN IN LICORICE EXTRACT.

For this determination I consider that a centrifuge is practically indispensable.

Two grams of licorice extract in a 100 cc. centrifuge tube are

allowed to stand overnight with 15 cc. water at room temperature. The mass is then stirred until completely disintegrated, 15 cc. 75 per cent. (by volume) alcohol, and 53 cc. 95 per cent. alcohol are added from a burette with stirring, to precipitate the starch and gums. This gives a total mixture containing 75 per cent. (by volume) alcohol when the licorice extract contains 25 per cent. moisture. After standing not less than three hours, the tube is centrifuged for five minutes at a speed of about 1500 R. P. M. The clear solution is poured off into a flask, the sediment is stirred up with about 75 cc. 75 per cent. (by volume) alcohol, centrifuged again and the clear solution is poured off. The sediment is stirred up a second time with 75 cc. 75 per cent. alcohol, centrifuged, and the solution is again poured off. The precipitated starch and gums are washed into a tared dish, dried and weighed. The combined three liquors are evaporated just to dryness from a water bath, preferably using vacuum to finish, and recovering the alcohol. The residue in the flask is dissolved in about 10 cc. hot water, the solution filtered through a small filter paper into a centrifuge tube graduated at 30 cc., the flask and paper are washed, and the volume made to mark.

The filtrate is cooled to 15° C., and the glycyrrhizin is precipitated with 3 cc. of 10 per cent. (by weight) sulphuric acid. The tube is allowed to stand in the ice box overnight, and is then packed in cracked ice for half an hour. The tube is centrifuged for a half a minute, and the clear liquid poured off. The precipitate is stirred up with 5 cc. ice water saturated with ether, centrifuged again for half a minute, and the clear liquid poured off. The sediment is again stirred up with 5 cc. iced ether-water, centrifuged, and the clear liquid poured off as completely as possible. The tube is kept cold throughout the operation and all of the glycyrrhizin is retained in the tube. Thirty cc. of warm 95 per cent. alcohol are added to the washed glycyrrhizin in the tube. This solution is retained to be united later to the second precipitate of glycyrrhizin. To obtain this, the combined filtrate and two washings obtained as above are neutralized with ammonia, evaporated to about 5 cc., transferred to a centrifuge tube, made to 10 cc., cooled and precipitated with 2 cc. 10 per cent. sulphuric acid. After standing overnight the tube is packed in ice for half an hour, centrifuged, and the clear liquor poured off. The glycyrrhizin is stirred up with 5 cc. iced ether-water, centrifuged half a minute, and the liquor poured off. A second washing with ice cold ether-water is given, using 3 cc. The precipi-

tated glycyrrhizin is dissolved in 10 cc. warm 95 per cent. alcohol. Both portions of dissolved glycyrrhizin are then filtered through a 70 mm. No. 40 Whatman paper into a weighed glass dish. The tubes and paper are washed with warm 95 per cent. alcohol and the washings added to the dish. Two drops of 5 per cent. ammonia are added to neutralize any traces of sulphuric acid. The solution in the dish is then evaporated to dryness and the glycyrrhizin weighed, after drying at 100° C. overnight.

The glycyrrhizin weighed is fairly pure and there seems no practicable method of purifying it further, at any rate for technical-analytical purposes.

DETERMINATION OF GLYCYRRHIZIN IN LICORICE ROOT.

The matter of determining glycyrrhizin in root is a little different from that of the determination in extract.

In the latter case, the root has been subjected to an aqueous extraction in the factory, and most of the resins and some of the bitter principles have remained behind in the spent root, and do not therefore enter into analytical consideration to any great extent.

The process of manufacture has effected a partial separation. In the case of determining glycyrrhizin in root, *all* of the constituents of the root must be reckoned with.

It has been suggested by some investigators that the root should be extracted with water, parallel to factory procedure in making licorice extract, the solution separated from the "spent root," evaporated and precipitated with sulphuric acid.

Linz has clearly pointed out the objections to such a procedure, which are, firstly, mechanical difficulties (powdered root is difficult to percolate with water and a solution is obtained which will not filter satisfactorily), and, secondly, a very impure glycyrrhizin is obtained.

I am therefore convinced that it is highly desirable to remove starch and gums by means of alcohol, because a clean liquid is obtained for manipulation, and a purer glycyrrhizin is weighed.

The glycyrrhizin is very conveniently removed from the root by means of dilute (75 per cent. by volume) alcohol, but this strength alcohol also removes from the root some resins and bitter principles, which may contaminate the glycyrrhizin weighed, to a greater or less extent. It is therefore necessary to consider preliminary re-

moval of resins and bitter principles, followed by removal of starch and gums.

Results of comparative experiments on this subject will now be communicated.

In one of the previous papers (this JOURNAL, June, 1912, p. 542) I have already shown that cold 95 per cent. alcohol completely removes from licorice root, resins and bitter substances together with some sugars, but does not remove any glycyrrhizin, and that the glycyrrhizin may then be completely removed by 50 per cent. alcohol. Linz confirms both of these statements.

My experiments on the preliminary removal of resins and bitter substances from the root before determining the glycyrrhizin, have been repeated and extended.

For this work powdered roots passing a 40-mesh screen were used. They were dried from their normal moisture content of about 8-10 per cent. to about 1 per cent., either by warming in an oven at about 50° C. for an hour or two, or by standing in a thin layer over sulphuric acid for a day. The roots were then extracted with solvents (ether or strong alcohol) and glycyrrhizin determinations were carried out on the roots after such extractions, and compared with glycyrrhizin determinations made directly on the original roots with 75 per cent. alcohol, in a manner similar to that described in the method for licorice extract.

SERIES 1.

PERCOLATION OF ROOTS WITH 95 PER CENT. ALCOHOL.

	Spanish.	*Russian.*	*Chinese.*
95% Alcohol removed	9.6%	11.4%	10.4%
60% Alcohol then removed	24.7%	25.3%	24.0%
Glycyrrhizin removed by 60% Alcohol	10.1 9.3	12.5 12.4	11.6 10.6
Glycyrrhizin in original root by 75% Alcohol.	11.1 10.9	13.3 14.1	10.7 12.0
	11.0 10.8	14.0 13.4	10.9 10.5

The 95 per cent alcoholic extracts, after drying, were treated with warm water. Only a minute trace of glycyrrhizin could be detected by tasting or by precipitation with sulphuric acid.

The residual root after the 60 per cent. alcoholic extraction contained no glycyrrhizin.

The direct results on original root are, on the average, somewhat higher than those on roots previously freed from resins and bitter principles.

I think there are three causes contributing to this effect:

1. Loss of a trace of glycyrrhizin in cold 95 per cent. alcohol.

2. Slight contamination of glycyrrhizin with resins and bitter principles, when those materials are not first eliminated.

3. The glycyrrhizin obtained when resins and bitter principles are first removed is inclined to be pulverulent, while that obtained from direct extraction of the root with 75 per cent. alcohol tends to adhere together in a mass. In the pulverulent form it is more subject to loss when the sulphuric acid is being washed out with ice water or ice cold water saturated with ether.

Of the three causes mentioned, I think the third has the greatest effect on the results.

Series 2.

Extraction of Roots with Hot Absolute Alcohol.

It was found very convenient to carry out these experiments in the extraction apparatus recommended by the Joint Rubber Insulation Committee (*Journ. Ind. Eng. Chem.*, January, 1914).

Extractions were also made in which 1 per cent. and 0.5 per cent. aqueous ammonia were added to the alcohol, with the thought that the ammonia might more thoroughly inhibit removal of glycyrrhizin by hot absolute alcohol, by forming the ammonium salt of glycyrrhizic acid, should any of the uncombined acid be present in the root.

It should be noted in the results below that the Spanish root was a different sample from that used in Series 1.

	Spanish.		*Greek.*		*Russian.*		*Anatolian.*	
	Alc.	Alc.+ 1% NH_3OH	Alc.	Alc.+ 1% NH_3OH	Alc.	Alc.+ 0.5% NH_3OH	Alc.	Alc.+ 0.5% NH_3OH
Hot Abs. Alcohol extracted	12.2	10.6	11.4	12.3	5.7	8.9	4.0	7.6
Glyc. after Hot Abs. Alcohol	8.1	8.2	6.4	5.9	12.1	10.3	11.0	10.1
Glyc. by direct method on root	11.5	11.2	10.2	11.6		14.1	14.5	14.3

Conclusions.—The "direct" glycyrrhizins are decidedly higher than those from roots extracted with hot absolute alcohol, and yet in the alcoholic extracts only a trace of glycyrrhizin was found.

Moreover, the "direct" glycyrrhizins were only slightly less pure than the others, judging by color and taste. Here, again, it seems to be a question of the physical condition of the glycyrrhizin,—that which is obtained from root previously treated with absolute alcohol is subject to greater loss in washing than that not so treated.

This is easily shown as follows:

The glycyrrhizin method which I have given for licorice extract prescribes two precipitations with sulphuric acid—the first giving the main portion, and the second giving a supplementary portion from the evaporated filtrate and washings from the first. When, now, this procedure is carried out with root on which no preliminary treatment with strong alcohol is given, the second portion is very small (the first main portion will be, say, 10 per cent., and the second usually 0.3-0.6 per cent.). When, however, the analytical process is applied to root which *has* been treated previously with strong alcohol, the washings from the main glycyrrhizin precipitate are very noticeably of darker color, giving a much larger second precipitate, and even the filtrate and washings from the second portion sometimes contain a considerable amount of glycyrrhizin. The first portion frequently drops to, say 5 per cent. and the second portion may be as much as 2 per cent., a clear indication of the reason for low results, viz., that glycyrrhizin has in this case been lost in the washing. The low results are not due, essentially, to removal of glycyrrhizin by the strong alcohol, and the high results in the "direct" method are not essentially due to contamination of the glycyrrhizin with resins and bitter substances.

There is no advantage in adding a little ammonia to the absolute alcohol. It renders the extraction of resins and bitter substances less sharp, and gives slightly lower glycyrrhizin figures.

The conclusions drawn from the table above were confirmed by repetition. In fact the discrepancies were even more marked.

	Spanish.	*Greek.*	*Russian.*	*Anatolian.*
Hot Abs. Alcohol Extract	11.2	8.4	10.4	8.3
Glycyrrhizin in residual root (based on original root)	5.8	7.4	8.9	9.8
"Direct" glycyrrhizhin	11.1	10.4	14.1	14.7

It was easy to notice in carrying out this series, how a considerable part of the glycyrrhizin from roots previously treated with hot

absolute alcohol, was dissolved in the washing of the precipitated glycyrrhizin with ice cold ether water.

The idea of extracting the root first with hot absolute alcohol was therefore abandoned, partly because such an extraction was not at all sharp, but chiefly because it left the glycyrrhizin subsequently obtained, in such a condition that it was subject to serious loss in washing.

Series 3.

Extraction of Roots with Ether.

Ether removes the resins from licorice root, but not the bitter principles. The ether extraction may be carried out in the apparatus of the Joint Rubber Insulation Committee. It may also be done by simply stirring up the powdered root (about 3 grams) in a 100 cc. centrifuge tube with 75 cc. Ether U. S. P., centrifuging for a few minutes, pouring off, and giving a second and third treatment with ether. The resins are very easily dissolved out by ether.

	Spanish.	*Greek.*	*Russian.*	*Anatolian.*
Ether Extract	2.5	1.3	4.2	2.3
Glycyrrhizin in residual root (based on original root)	9.6	10.1	12.3	14.0
"Direct" glycyrrhizin	11.1	10.4	14.1	14.7

Note may here be made of a difference remarked in the course of the two sets of glycyrrhizin determinations.

My method calls for evaporation of the 75 per cent. alcoholic solutions containing the glycyrrhizin, just to dryness, followed by solution in 10 cc. hot water. In the series in which the root had been treated with ether to remove resins, complete solution of the residue from 75 per cent. alcohol, was obtained when 10 cc. of water was added. When, however, the original root is not treated with ether, complete solution is not obtained in 10 cc. water. An insoluble residue remains which was found to be soluble in ether. The "direct" method therefore of itself eliminates the resins to some extent, inasmuch as it leaves at least a part of them undissolved in water after evaporation of the solution in 75 per cent. alcohol.

Having rejected the preliminary extraction of the root with hot absolute alcohol, I have now to choose between four methods:

1. Direct treatment of root with 75 per cent. alcohol.
2. Treatment with ether, followed by 75 per cent. alcohol.

3. Treatment with cold 95 per cent. alcohol, followed by 75 per cent. alcohol.

4. Treatment with cold absolute alcohol, followed by 75 per cent. alcohol.

A new series of determinations was now made in order that the four methods could be compared simultaneously.

The Russian root in this series was a new sample, and therefore the results on this one sample are not to be compared with the earlier series.

Instead of the tedious method of percolating the powdered roots with ether, 95 per cent. alcohol and absolute alcohol, extractions were made with these solvents in centrifuge tubes. The procedure was to stir up 3 grams of the ground root with 75 cc. of the solvent for 15 minutes, centrifuge, pour off the clear liquor completely, and repeat with two more 75 cc. portions, stirring each time for 15 minutes before centrifuging. This method gives a bright liquor, which can be poured off from the root to the last drop. The amounts of extracts obtained agreed excellently with those from the slow percolation method, and the extraction is finished in little more than an hour, the last liquor being practically colorless.

Series 4.

Comparison of four methods.

	Spanish.		*Greek.*		*Russian.*		*Anatolian.*	
Ether Extract	2.0	2.3	2.4		3.2	3.2	2.1	2.5
Cold Absolute Alcohol Extract	5.5		5.0		6.5	7.2	4.7	6.7
Cold 95% Alcohol Extract	8.9		7.8		12.0	11.7	10.3	10.0
"Direct" Glycyrrhizin	11.5	11.2	11.0	10.7	12.6	13.2	14.7	14.8
Glycyrrhizin after Ether	10.4	10.4	10.1		10.2	10.6	13.8	14.1
Glycyrrhizin after Abs. Alcohol	9.0		8.9		9.6	9.8	12.9	11.1
Glycyrrhizin after 95% Alcohol	8.4		8.2		8.0	8.8	12.1	9.8

After extracting the various roots with ether, 95 per cent. alcohol or absolute alcohol, and then treating the residual roots in the tubes three times with 75 per cent. alcohol, the residues were extracted with a hot 5 per cent. solution of ammonia to determine whether all of the glycyrrhizin was removed.

The treatment with hot weak ammonia extracts starch and gums, but the solutions were found to contain no glycyrrhizin.

One notices very clearly that the more material removed by the preliminary extraction, the lower the value for glycyrrhizin subsequently obtained.

The most obvious explanation is not the true one. One might think that:

1. Either the preliminary solvent removed glycyrrhizin.

2. Or the glycyrrhizin was more or less contaminated with bitter substances according as they were less or more removed by the preliminary treatment.

The first possibility is easily disproved by examining the ether or alcohol extracts for glycyrrhizin. Never more than a trace is present.

The second possibility may account for a small part of the differences in the values, but judging by taste and color there can be no large amount of impurity in the glycyrrhizin obtained. The main cause of the differences, as already explained in detail, is that, the more non-glycyrrhizin removed in the preliminary treatment, the more subject to loss by washing is the glycyrrhizin, on account of being then left in a granular form rather than in a compact form which can be kneaded with the ice-cold wash-water.

In summarizing, it must be remembered that no known method weighs *pure* glycyrrhizin. We have to choose the method weighing as pure a glycyrrhizin as possible, and in which the loss in manipulation is as low as possible.

With the preliminary alcoholic extraction I feel that serious manipulative losses are difficult to avoid, and in some cases inevitable.

On the other hand I feel that a direct treatment of the root with 75 per cent. alcohol yields a glycyrrhizin which is contaminated a little more than necessary with impurities.

As the best available compromise I therefore choose an ether extraction to remove resins, followed by extraction with 75 per cent. alcohol to obtain glycyrrhizin.

The details of the method are here set forth:

DETERMINATION OF GLYCYRRHIZIN IN LICORICE ROOT.

The sample of ground root (it is not necessary to specify any particular degree of fineness, but it should be not coarser than 20 mesh) is dried to a moisture content of not more than 2 per cent. This is easily accomplished by allowing to stand in an oven for an hour or two at about 50° C., or by spreading out a thin layer for a day in a sulphuric acid desiccator.

Three grams of the powdered root are extracted in the Extraction Apparatus of the Joint Rubber Insulation Committee with 50 cc. Ether U. S. P. The extraction is finished in about one hour and will remove from most kinds of licorice root, 1.5 to 4.5 per cent. resins.

The residue in the thimble is dried and transferred as completely as possible to a 100 cc. centrifuge tube. The thimble is washed with 75 per cent. (by volume) alcohol and the washings poured into the centrifuge tube. The volume of 75 per cent. alcohol in the tube is made up to 75 cc. The mixture is stirred frequently and then allowed to stand overnight.

The ether extraction may also be done in a centrifuge tube by stirring for 15 minutes each time with three 75 cc. portions of ether, centrifuging and pouring off the clear liquor after each treatment. In this case there is no thimble to dry and wash, the ether being removed by placing the centrifuge tube in the oven for a few minutes; 75 cc. of 75 per cent. alcohol are then added to the root in the tube.

The subsequent treatment follows that already described for licorice extract—and comprises two further treatments with 75 per cent. alcohol, stirring for 15 minutes each time, centrifuging and pouring off the clear liquors, evaporating to dryness, dissolving in 10 cc. water, filtering up to 20 cc. (instead of 30 cc. prescribed for 2 gms. Licorice Extract), precipitating with 3 cc. 10 per cent. sulphuric acid, etc., as already described. Wash twice with ice cold water saturated with ether, using 5 cc. each time. Precipitate a second portion of glycyrrhizin by evaporating the filtrate and washings from the first portion to about 5 cc. after neutralizing with ammonia, subsequently transferring to a tube marked at 10 cc. and using 2 cc. 10 per cent. H_2SO_4 for the second precipitation, and washing twice with iced ether-water as already described. The two fractions are dissolved in 30 and 10 cc. respectively of warm 95 per cent. alcohol, filtered, and united. Two drops of 5 per cent. ammonia are added to fix any trace of free sulphuric acid and the solution evaporated to dryness, dried at 100° C. and weighed.

There is no doubt that the figures given in the literature for glycyrrhizin in licorice root are too low.

Kraemer in his new book, "Scientific and Applied Pharmacognosy" (1920), gives a figure of "about 3 per cent." for glycyrrhizin in Russian licorice root. Tschirch in his "Handbuch der Pharma-

kognosie" gives 6.42-7.13 per cent., although in an earlier publication he speaks of 3 per cent.

The method, which I have given above, yields a glycyrrhizin more nearly approaching purity than that of any method heretofore published. The glycyrrhizin obtained by my method (ether extraction, followed by 75 per cent. alcohol) is light in color, intensely sweet, and practically free from resins and bitter principles. Yet I find figures from about 10-14 per cent., the former figure being for Spanish and Greek roots, and the latter for Anatolian, with Russian and Chinese intermediate.

Licorice extracts should contain about twice as high a percentage of glycyrrhizin as the corresponding roots, but there is no doubt that, in factory practice, a considerable loss of glycyrrhizin through hydrolytic decomposition occurs.

With regard to determining other analytical items in licorice extract and root, there is little new to add to the information contained in my earlier papers.

In root one would usually determine moisture, total ash, ash insoluble in hydrochloric acid (sand, dirt), resins (ether extract), glycyrrhizin, sugars, crude fibre, and screen analysis (on powdered roots). The sugar determination is made with Fehling solution before and after inversion, employing either the filtrate and washings from the glycyrrhizin determination, or an original portion of root, using normal lead acetate and following suitable methods given by the Association of Official Agricultural Chemists, of Washington, D. C.

Crude fibre is also done according to the A. O. A. C.

In licorice extract one may determine moisture, ash, matters insoluble in cold water and in hot water, starch and gums, glycyrrhizin and sugars.

Matters Insoluble in Cold Water.

Two grams of the licorice mass are weighed into a small copper-gauze basket, which is suspended in a 100 cc. centrifuge tube. The tube is nearly filled with cold water, and when the paste is completely disintegrated (after about 18 hours), the basket is agitated, washed and removed. The contents of the tube are whirled in an electrical centrifuge for 10 minutes at about 1500 R. P. M. The clear liquor is poured off, and the sediment stirred up with fresh water

and whirled in the centrifuge for a further 10 minutes. The liquor is again discarded and the sediment is washed into a weighed glass dish and evaporated, and the residue, dried in an oven at 100-105° C. for 24 hours, is weighed.

Matters Insoluble in Hot Water.

Two grams of licorice mass are placed in a 100 cc. centrifuge tube, which is nearly filled with hot water. This is kept hot on a suitable bath and stirred at intervals until all soluble matter is in solution. The further operation is carried out as under "Matters insoluble in cold water," using hot water throughout.

Sugars are determined in the filtrate from the glycyrrhizin determination, or preferably on an original portion of the licorice extract, using neutral lead acetate to clarify, and following directions of the Association of Official Agricultural Chemists.

SUMMARY.

1. The method of Linz for the determination of glycyrrhizin in licorice extract is discussed.

2. A method is given for the determination of glycyrrhizin in licorice extract.

3. Comparative experiments have been made on various methods for separating part or all of the resins and bitter principles from licorice root, before proceeding to the determination of glycyrrhizin.

4. A method is given for the determination of glycyrrhizin in licorice root, involving removal of resins with ether, followed by extraction of glycyrrhizin with 75 per cent. alcohol.

5. The figures for glycyrrhizin in licorice root, published by other investigators, and in books, are too low.

6. The other constituents of licorice extract and root, which may be advantageously included in an analysis, are mentioned.

I have been very ably assisted in this work by Messrs. Bertrand Schneeberg and Milton Hartman, and express my thanks to them, as well as to the MacAndrews & Forbes Company, which has generously encouraged the work.

LABORATORY OF THE MACANDREWS & FORBES COMPANY,
Camden, New Jersey.

June 17, 1921.

SOUR SALT, A NEW SYNONYM FOR TARTARIC ACID OR CITRIC ACID.*

By CHARLES H. LAWALL, PH. M.

During the year 1920 the Pure Food Bureau of the Pennsylvania Department of Agriculture received a number of complaints from customers of small groceries and delicatessen shops, particularly in the sections where Jewish inhabitants predominated. These complaints were concerned with the alleged adulteration of a substance known as "sour salt," which was purchased either in bulk or in small cartons under that name and was used to reinforce vinegar in giving acidity to certain foods, particularly to sour soups.

Upon investigation it was found that some of the firms selling the product in cartons were labeling it "sour salt" and also "tartaric acid" on the other side of the carton. The substance is always found in crystal form when sold under this name.

When samples were taken from the stores concerning which complaints were received it was found upon analysis that the product, instead of consisting of tartaric acid, or citric acid, as is supplied in some localities, was composed wholly or in great part, of alum crystals.

As alum is specifically prohibited by the food laws of Pennsylvania for sale or use in foods there was no difficulty in obtaining convictions in the majority of the cases which were instituted, for adulteration under the Food Act.

In one case, however, the defendant (a wholesaler) escaped conviction by perjuring himself to the effect that he had purchased the mixture of tartaric acid and alum crystals from several large chemical manufacturers, under the name "tartaric compound," and that he did not know that it contained alum. After his acquittal the matter was taken up with the manufacturers named, in order to learn the facts in the case, and it was shown that the defendant had been purchasing tartaric acid and alum separately, in original containers and was undoubtedly doing the mixing himself.

Some time subsequent to this investigation the Bureau of Chemistry of the U. S. Department of Agriculture issued a "Service and Regulatory Announcement" covering the subject, as follows:

* Read at a meeting of the Penna. Pharm. Assoc., June, 1921.

"353—Sour Salt.

"Investigation has shown that under the name 'sour salt,' purchasers expect to receive an article consisting of tartaric acid, or citric acid, or a mixture of both.

"A product containing alum, labeled as sour salt is regarded as both adulterated and misbranded under the Food and Drugs Act."

This is an interesting example of the birth of a new synonym, for a careful search of the literature of pharmacy or even of general reference works has failed to show any record of the synonym having been recorded. Although synonyms are usually misleading and unreliable, this one will have to be noted and observed, because of the official sanction which it has received from an important bureau of the government at Washington.

SOME NOTES ON THE ASTRINGENCIES OF RED ROSE AND PALE ROSE.*

By Josiah C. and Bertha L. DeG. Peacock.

Last year a paper entitled "The Tannin of Red Rose" was read before this body. In it were discussed the properties of that astringent principle with the result that characteristic differences from other known astringent principles were shown.

Because of the interesting features of this constituent of Red Rose an examination of Pale Rose was undertaken for report to this meeting.

Concerning the presence of a "tannin" in Pale Rose there seems to have been doubt, for, though some authors state positively its existence in small amounts, Maisch, in his "Manual of Organic Materia Medica," 1892, gives as constituents: "Little volatile oil, mucilage, sugar, tannin (quercitrin?), malates, etc." Certain it is that the matter had not attracted the necessary attention to decide this question.

It is very natural to base one's inference regarding the presence and relative amount of "tannin" on the simple test of taste, as mentioned last year, when it was pointed out that the astringency and bitterness of Red Rose are experienced simultaneously and are

* Read at a meeting of the Penna. Pharm. Assoc., June, 1921.

about equally pronounced. This description, however, does not apply to Pale Rose, which is strikingly bitter rather than astringent.

It is desirable, for the sake of a proper understanding, to state at once that "the tannin of red rose" is present in Pale Rose as well, but in a very much less proportion.

A fair impression of this amount may be gathered from the fact that a kilo of Pale Rose did not yield sufficient to permit of the "tannin" being entirely separated from adhering matter, while the same weight of Red Rose gave an abundant sample of the purified principle.

In the case of Pale Rose, as in Red Rose, the presence and close association of much larger amounts of the "quercitrin" of other observers makes the isolation of the astringent principle both tedious and wasteful.

For a proper comparison of the following notes on Pale Rose, reference should be had to the article of last year on Red Rose.

When Pale Rose was boiled with successive portions of water, the reddish color of the material and the bitterness were entirely removed, and they failed to reappear upon subsequent drying of the undissolved portion. The infusion was feebly acid to litmus. While the first impression made by this infusion on taste was of bitterness, the last was plainly of astringency. Diluted sulphuric acid developed a reddish color and a distinct opalescence in the infusion. Upon boiling, a precipitate of burr-like aggregates was formed, identical in appearance and properties with those obtained through like treatment of Red Rose.

Except for the much smaller proportion of astringency and the relatively greater bitterness, the physical properties of the infusions of the two roses were found to be very similar, while behavior toward reagents further demonstrated a similarity of ingredients. For instance, from the infusion of Pale Rose, as from that of Red Rose, hide powder removed all astringency and bitterness; all acidity to litmus, and all color except a straw-yellow. The resultant fluid was changed to pink by the addition of diluted sulphuric acid.

In an attempt to isolate and purify the astringent substance, the bulk of the infusion was concentrated, cooled and shaken with acetic ether, which solvent removed the greater part of the astringent principle, as subsequently found through the failure of diluted acid to produce in this liquid the burr-like aggregates upon heating.

The recovery of the acetic ether yielded a small amount of

thick syrupy residue; it consisted of the astringent principle and the substance which others have called "quercitrin." Efforts to obtain the "tannin" in a porous condition were unsuccessful in operating upon this quantity. But it was converted into scale form by dissolving in alcohol and evaporating with heat on an enameled surface.

Although the purification was not an entire success, the material by displaying the peculiar properties of "the tannin of red rose" in its behavior toward reagents, proved its identity with that substance. Especially was this fact established by the production of the burr-like aggregates when the solution of the principle was treated, hot or cold, with diluted mineral acids.

There is every reason to believe that this astringent substance is present in both drugs, but in very much smaller quantity in Pale Rose, perhaps less than one per cent. of its weight.

As it is becoming more and more evident that astringency is not a characteristic of any one substance, no more than the property of bitterness is indicative of any single material or group of them, we question the desirability of continuing to apply to such principles (other than gallotannic acid) the names "tannic acid and tannin." Instead, as a means of obviating a possibly improper terminology, the suggestion is offered that such plant substances may well be grouped under the name of "astringents," with a prefix to indicate the source; as for example: quercastringent, rosastringent, etc.; until they are chemically classified, and even then a name so practical as these may be preferable to an intricate one which details the chemical structure of the substance.

Effect of Mildew Upon Red Rose and Pale Rose.

Another feature of the paper presented in 1920 was a reference to a crystalline principle which seemed to develop under the influence of mildew growth upon an unstrained infusion of Red Rose. By means of an ether extraction of these materials this substance was obtained in fine white or colorless crystals, but in very small amount.

To further study this matter, and more especially this time to confirm this behavior, about 500 grams of Red Rose were exhausted with ether to remove any pre-existent ether soluble contents.

This treatment revealed the presence of fatty and waxy con-

stituents and of a crystalline substance having the same appearance and solubilities as the one being sought.

Continuing the experiment the ether exhausted residue (unchanged in appearance) was freed of this solvent, and mixed with water into a mush, which was exposed to induce a growth of mildew.

In the course of two weeks, the surface was covered with a thick layer of mycelium. This covering was removed with as little of the Red Rose as possible, and extracted with ether; which removed but a trifle of the crystalline substance.

The mush was then strained to separate the aqueous portion, and this clarified by further straining. This liquid was a deep wine-red color, strongly acid to litmus, astringent, bitter, and decidedly musty, but still strongly suggestive of rose. Ether shaken with this fluid removed the crystalline principle, thus confirming its formation under the circumstances arranged for. From this portion of the mush, the yield was several times what ether extracted directly from the Red Rose.

It is presumable that this crystalline substance is derived from some water-soluble constituent of the rose, whether the "tannin" or not. To examine this subject, the solid portion of the mush was washed with cold water while ever color was removable; then mixed again with water and the resulting mush exposed to induce mildew as before. The development of mildew was very slow and sparce compared to its appearance and amount in the previous experiment. The watery portion was found to contain none of the crystalline principle.

The same experiments were carried out on Pale Rose with the results that a small quantity of a crystalline substance, apparently the same as that from Red Rose was directly extracted by ether; while a less amount was obtained in the experiment with mildew.

These experiments shall be repeated to determine whether the crystals will develop in the mush without the appearance of mildew.

It is within the bounds of probability that this crystalline substance is related to the astringent principle.

The solubility of this crystalline principle in chloroform distinguishes it completely from the astringent principle.

The burr-like aggregates melt when heated and sublime in crystalline form, tending to re-assume this peculiar manner of association.

THE CENTENNIAL CELEBRATION OF THE PHILADELPHIA COLLEGE OF PHARMACY AND SCIENCE.

INCLUDING A REPORT OF THE GRADUATING EXERCISES.

The Centennial Celebration of the Philadelphia College of Pharmacy and Science, held in Philadelphia from June 12th to 15th, is of nation-wide interest; for it marked the Centennary also of Pharmaceutical Education in America. It was the occasion for a retrospect reaching back almost to the very beginning of American Pharmacy,—and for the summing up of its future possibilities.

The belief was expressed by Rear-Admiral William C. Braisted, the new President of the Philadelphia College of Pharmacy and Science, and by Dean Charles H. LaWall, as well as by other prominent educators who attended the exercises that pharmacy and medicine must eventually come together in a field of co-operation; that the profession of pharmacy, one of the oldest in history, must step forward and upward to the higher plane now occupied by the other professions.

These speakers stated more than once that this advance is at hand. In his address at the reception tendered to him in the Bellevue-Stratford Hotel, President Braisted told the graduates to do more than become just druggists.

"A pharmacist should employ much of his time in research work, so that he may fit in with the general advance in dignity and importance that is coming to pharmacy," he declared. "Each man should have in the back of his drug store a laboratory, where he could devote hours to experimentation and research, where he could test the purity of water and of milk, where he could be of assistance to the community doctor and make himself a valuable aid to the public. This work would be useful in large cities, and it would be invaluable in small centres of population, where, at present, there are no laboratories. It would be a big step toward the coming co-operation of medicine and pharmacy."

In his predictions, Dr. LaWall said to the delegates to the centennial:

"The teaching of pharmacy was inaugurated in this country one hundred years ago by the apothecaries of Philadelphia when they founded the College of Pharmacy and Science. Since then the institution has undergone many changes, as have all other branches

of education, but pharmaceutical progress has been retarded, largely because of the lack of supporting legislation in many of the States.

"After years of waiting, we may say that now we are on the verge of a great advance, and within ten years more progress will be made than has been recorded during the past half century.

"The interdependence of medicine and pharmacy was never more in evidence than at present for with the introduction of biological preparations, the physician is compelled to rely upon the pharmacist for distinctive and important scientific assistance in combating the manufacture and sale of worthless nostrums and in educating the public in hygiene and health conservation."

In connection with this development idea, it is interesting to note the splendid future that has been planned for the Philadelphia College of Pharmacy and Science. One phase of this was touched upon by President Braisted when he spoke to the graduates and alumni, to whom he was officially presented for the first time on the evening of June 14th. He said:

"My whole effort will be devoted toward making the College of Pharmacy and Science a larger and better institution. I want to help to bring about the co-operation between medicine and pharmacy. I wish, by means of this fine institution, to produce the super-pharmacist of the future.

"We are going to start next fall with an increased personnel and enlarged facilities. We must stay in our old building at 145 North Tenth Street for three or four years more, and this summer it will be renovated and improved in many ways. But the plan to secure funds with which to construct a new building has not been abandoned; it has been merely postponed.

"There are men now looking for a site in this city, and I am sure that they are going to find an extremely good one. I hope that when we do decide to locate at a certain place, the site will be given to us by citizens of Philadelphia in recognition of one of its oldest and most famous educational institutions. I am also sure that there are at least one or two wealthy men here who will come to our aid; there is no doubt in my mind that we will get all of the money that we need."

As a part of the expansion of the College it was announced during the centennial that beginning next fall, courses will be inaugurated leading to degrees of bachelor of science in pharmacy, chemistry, bacteriology and pharmacognosy. Other phases of the proposed expansion of the College were enumerated by Dr. LaWall as follows:

The conducting of a series of fifteen lectures on popular scientific subjects in the College.

The development of research service to the medical profession.

The institution of research departments, which shall aid the manufacturing interests allied to pharmacy.

The founding of laboratories for the express purpose of serving the City and State in an impartial solution of problems such as the quality of foods, the purity of drugs and chemicals and other scientific questions affecting the public welfare.

The development of pure scientific research.

The development of a public museum of drug and chemical products and pharmaceutical and chemical manufactures.

The creation of a botanical garden, particularly devoted to plants of medical and economic importance.

The proper housing of the present library of more than 20,000 volumes of scientific works.

Leaving aside the question of the significance that underlay the celebration, it was upon the face a most pronounced success. The plans for the celebration had been several months in the fruition, and as a result members of the alumni in all parts of the country had received invitations long in advance of the date set for the beginning of the exercises. It is estimated that more than one thousand of the "old grads" attended, some of them coming from points as far removed as the Pacific Coast. The events were also participated in by the two hundred and twenty-five students of the graduating class, the largest such body in the past twenty-five years.

The baccalaureate service which opened the centennial was held on Sunday afternoon, June 12th, in the Episcopal Church of St. Luke and the Epiphany, at Thirteenth and Spruce Streets. An appropriate sermon was preached there by the rector of the church, the Rev. Dr. David M. Steele.

On Monday afternoon the alumni met in a lecture room at the College and there expressed their unqualified endorsement of the selection of Admiral Braisted as President of the institution. This was especially gratifying in view of the fact that it was the first time the name of the new president had been put before the alumni since his election. After an address by the retiring president of the Alumni Association, Dr. William Duffield Robinson, an election of officers for the coming year was held, and the following men were chosen:

Russell T. Blackwood, president; Mort M. Smith, first vice-president; Ivor Griffith, second vice-president; Joseph W. England, recording secretary; William H. Gano, treasurer, and Eugene Eberle, corresponding secretary. The directors selected were: Frank R. Rohrman, F. N. Moerk, W. R. Decker, Ralph R. Foran and A. T. Hahn.

Professor E. Fullerton Cook, a member of the faculty, gave an illustrated lecture after the elections, in which he recited the history and traditions of the College from its founding at a meeting of apothecaries in Carpenters' Hall on February 23, 1821. Professor Cook had gotten together a remarkable collection of photographs for this event, including pictures of Charles Marshall, the first president of the institution; members of the major faculty, including some of the pioneers of pharmacy in this country, and many other photographs of equal interest.

In the evening, the annual banquet of the alumni, trustees and students in the graduating class was held in the auditorium of the College. The exceptional heat of the day proved no detriment to the attendance at this popular function.

The centennial day exercises were held in the ball room of the Bellevue-Stratford Hotel on Tuesday morning, June 14th. The meeting was honored by the presence of William H. Carpenter, Ph. D., Provost of Columbia University, and by S. Solis-Cohen, M. D., of Philadelphia, both of whom delivered excellent addresses.

An academic atmosphere was given to the exercises by the faculty and graduating class when they marched into the room attired in caps and gowns. Headed by the officials of the College and guests, the procession marched down through the center aisle of the room, the speakers, members of the board of trustees and faculty taking seats upon the stage, and the graduating class occupying the front seats that were reserved for them.

The meeting was called to order by President Braisted at 10:40 A. M. The invocation was then asked by Dr. C. B. Lowe. Dr. Braisted, after delivering a brief but very interesting address, introduced as the chief speaker of the morning Dr. William H. Carpenter, the Provost of his own Alma Mater, Columbia University.

Dr. Carpenter spoke upon "The Significance of Education," taking up several important phases upon the question of education. He dwelt especially upon the importance of a proper balance of mind and body in acquiring a good education, pointing out that a sound

mind and a sound body were essential factors. He also declared that while in the long run the dependence of mind upon body is not very strong, it is true that the mind dominates the body and a man with an ill-equipped body and whose mind is efficient is handicapped from the start. He defined education briefly as a knowledge of values, and after touching upon the history of education he brought out that a new age postulates a new education and that at the present time there is a demand for material results. Dr. Carpenter then drew attention to influence of the heart upon the mind and quoted the words "as a man thinketh in his heart so is he," when he stated that the well-informed mind could be used for good or evil according to the nature of the thoughts originating in the heart. He emphasized the importance of the heart being right and asserted that after all the end of all education is not to make a living, but to live.

The next speaker to be introduced by President Braisted was Dr. S. Solis-Cohen, of Philadelphia. The subject of Dr. Cohen's address was "The Relation of Pharmacy to Medicine." He opened his address with a few remarks with regard to the progress of the Philadelphia College of Pharmacy and Science, referring to the advancement that has been made by the institution and the good work that it has accomplished and stated that the penalty of well-doing is the obligation to do better. Dr. Cohen spoke of the College as an institution which is soaring to an apex or summit which has not yet been reached, nor is this summit yet in sight. He then took up, very interestingly, the history of pharmacy and medicine from their origin as a single art to their gradual separation into the two professions. In the words of Dr. Cohen, pharmacy is now a sister art to that of medicine. Dr. Cohen, in his remarks, strongly censured the excessive use of the synthetic coal tar products at the present time and declared that their abuse as home remedies is very harmful. Dr. Cohen also paid a glowing tribute to Dr. F. E. Stewart for his work in establishing proper relations between pharmacy and medicine. He closed his excellent and, at times, humorous address, by directing attention to an appreciation of the importance of the soul, stating that the mind is at its best only when in accord with the soul.

Professor Charles H. LaWall was the next speaker to address the meeting upon "The Future of the Philadelphia College of Pharmacy and Science." The Dean spoke in his usual eloquent and inspiring manner, dwelling upon the ambitions of the College and tak-

ing up in detail the plans and prospects that will no doubt have important influences upon its future development and expansion.

Professor E. Fullerton Cook then made the announcements for the balance of the day, including the assignments of the various classes to their class luncheons and reunions, after which the meeting was brought to a close.

The climax of the centennial came that night with the reception and dinner to Admiral Braisted. It was probably the most brilliant affair in the annals of the institution. The reception was held prior to the dinner, and the members of all classes of the institution lined up in the Clover Room of the hotel, each graduate bearing a placard announcing the year of his graduation.

After this ceremony, the "grads" marched into the ball room, each class in the order of its age. At the head of this profession was Samuel Gerhart, member of the Class of 1854. Last of all came the young men and women who were graduated this year. Dr. LaWall acted as toastmaster, introducing the guest of honor, Dr. Braisted, and a number of other speakers, including Dr. Robinson, who represented the Alumni Association; Major Clark, of the United States Army; Joseph W. England, who presented a résumé of College History; Dean Sturmer, who spoke on the Medico Chi merger; Mr. Christensen, of the National Board of Pharmacy; Dean Bradley, of Massachusetts, and others.

The graduation, which marked the close of the centennial celebration, was held in the Academy of Music on Wednesday morning. In addressing the graduates, Admiral Braisted impressed upon them the fact that they composed the one hundredth class of their alma mater, and advised them to achieve happiness and success in their future life by adhering to the principles of Christianity.

The other speaker of the occasion, Dr. Herbert W. Hess, Professor in the Wharton School of the University of Pennsylvania, urged that every citizen remember that their individual thinking makes or mars the nation.

Diplomas were awarded to one hundred and eighty-seven students by Admiral Braisted, and the remaining sixty-eight will receive their sheep skins on reaching legal majority, or on fully satisfying the practical experience requirement. The prize scholar was Miss Anne Goldberg, who won four prizes, including the alumni gold medal awarded each year to the student having the highest scholastic average for the year.

Degrees of master in pharmacy were conferred in absentia upon Rear-Admiral Edward Rhodes Stitt, Surgeon General of the United States Navy, and a graduate of the College, and upon Dr. Edward Kremers. The same degree was conferred upon Samuel L. Hilton and Josiah C. Peacock. Degrees of master in pharmacy in course were conferred upon Ivor Griffith, a member of the College Faculty and Editor of the AMERICAN JOURNAL OF PHARMACY, and Ellery H. Harvey, now pursuing special work in plant chemistry.

Upon Miss Florence R. M. McGarrity, a former student, was conferred the degree of doctor of pharmacy. Dr. McGarrity has been elected as a teacher of chemistry in an American college in Constantinople.

Following is a list of the graduates:

Bachelor of Science in Pharmacy and Chemistry (B. Sc.).

Name	Where From
Keller, Alexander George, Jr.	Pennsylvania
Weber, Robert Boyd	North Dakota

Doctor in Pharmacy (P. D.).

McGarrity, Florence R. M., P. C.	Pennsylvania

Pharmaceutical Chemist (Ph. C.).

Weinstein, Samuel	Virginia

Graduate in Pharmacy (Ph. G.).

Allen, John Wesley	Pennsylvania
Arnold, Alfred William	Pennsylvania
Bausher, George Joseph	Pennsylvania
Beaver, Ralph	Pennsylvania
Beauchamps, Eurico R.	Porto Rico
Bill, Howard L.	Pennsylvania
Boyd, Lardner Clark	Texas
Brill, Edward A.	Pennsylvania
Bruce, Edward Douglas	Pennsylvania
Burns, Joseph Leo	Pennsylvania
Caldwell, Archie Lee	Missouri
Chambliss, George Edward	Tennessee
Champaine, David	Pennsylvania

Name	Where From
Clewell, Rollin Earl	Pennsylvania
Colahan, Frank Patrick	Pennsylvania
Cordier, Lee Garfield	Ohio
Davendish, Sanford Jos.	Pennsylvania
Davis, Robert V. S.	Pennsylvania
Deans, John	Pennsylvania
Detweiler, H. W., Jr.	Pennsylvania
Devine, Thomas Joseph	Pennsylvania
DeVittorio, Carl Donald	Pennsylvania
Dixon, David Bainbridge	Pennsylvania
Dombrowski, Henry Jos.	Pennsylvania
Donovan, Walter Ephraim	North Dakota
Eddy, Thomas L.	Pennsylvania
Episcopo, Harry N.	New Jersey
Ewing, Charles Henry	Pennsylvania
Finegan, Edward Thos.	New Jersey
Fox, Louis	Pennsylvania
Fox, Ray Linaham	Pennsylvania
Frock, Charles Thomas	Pennsylvania
Funcheon, Margt. Gert.	Pennsylvania
Garber, Hallie Jackson	Pennsylvania
Gershenfeld, Herman	Pennsylvania
Gold, Adolph E.	Pennsylvania
Goldstein, Benj. M.	Pennsylvania
Golland, Jack Kendall	Pennsylvania
Goodman, Jacob	Pennsylvania
Green, Eli Noah	Pennsylvania
Gross, David	Pennsylvania
Haas, Earl Oren	Pennsylvania
Haentze, Frederick Edw.	Pennsylvania
Haines, Emerson Snyder	Pennsylvania
Hall, Frederic Compton	Ohio
Hamilton, S. S., Jr.	Pennsylvania
Handelsman, Benjamin	Pennsylvania
Harper, Ernest Robert	Pennsylvania
Harrity, Michael A.	Pennsylvania
Henrie, Robert R.	Pennsylvania
Hertzler, Gaius Bricker	Pennsylvania

Name	Where From
Hoffstein, Albert Herman	Pennsylvania
Hughes, Paul William	Pennsylvania
Jacob, David	Pennsylvania
Jacobs, Alexander H.	New Jersey
Jaffe, Hyman	Pennsylvania
Jaffe, Max	Pennsylvania
Johnson, Sidney	Pennsylvania
Juresco, Samuel	Pennsylvania
Kane, Joseph Thomas	Pennsylvania
Katz, Ray Parris	Pennsylvania
Kearney, Francis Joseph	Pennsylvania
Kellam, Warrington E.	Pennsylvania
Kepner, Russell Albert	Pennsylvania
King, Raymond Wesley	Missouri
Kinney, John Francis	Pennsylvania
Klein, Louis	Pennsylvania
Klonoski, E. J.	Pennsylvania
Kreider, Obed Emmert	Pennsylvania
Kutcher, Maurice Richard	Pennsylvania
Lapayowker, Adolph	Pennsylvania
Lehman, Anna Isabel	Pennsylvania
Lerman, Benjamin	Pennsylvania
Lieber, Maurice L.	Pennsylvania
Lynn, Carl Harold	Pennsylvania
McCoubrie, John Hubert	New Jersey
McGarr, William James	Pennsylvania
McVey, Vane Howard	Wisconsin
Meier, Virginia A. P.	Pennsylvania
Meissner, Robert Meyen	Indiana
Mest, Girard Stephen	Pennsylvania
Miraldi, Valdo Antonio	Pennsylvania
Mokes, Albert Bert	Pennsylvania
Mowrer, William Taylor	Pennsylvania
Myerson, Myer	Pennsylvania
Nelson, Augustus W.	N. Carolina
Norton, Allison Sheeler	Pennsylvania
Novak, Edward Andrew	Pennsylvania
Noveck, Morris	Pennsylvania
Nyhart, Natalie Neita	Pennsylvania

Name	Where From
O'Connor, William Jas.	Pennsylvania
O'Mara, John Aloysius	Pennsylvania
Olsen, Olaf J.	New Jersey
Pentz, Fletcher Orville	New Jersey
Point Leonare Joseph	Pennsylvani..
Potts, Milton George	Pennsylvania
Powell, Alfred Leon	Pennsylvania
Puhlick, Theodore J.	Pennsylvania
Randolph, Coleman L.	Missouri
Reinard, William Ray	Pennsylvania
Reynolds, Ralph Eli	Maryland
Rosenfeld, S. W.	Pennsylvania
Schneider, Karl	Pennsylvania
Schor, Morris	Pennsylvania
Schwartz, David M.	Pennsylvania
Shoemaker, Wm. Guy	Pennsylvania
Shuman, Morris	Pennsylvania
Singer, Irvin	Pennsylvania
Sless, Ephraim Gershin	Pennsylvania
Smith, Amos Clark	New Jersey
Smith, Winfield F.	Pennsylvania
Snively, Fred Hege	Pennsylvania
Solorzano, Porfirio	Bermudez
Solot, Louis J.	Pennsylvania
Sorber, Russell R.	Pennsylvania
Spangler, Luther E.	Pennsylvania
Stark, Louis	Pennsylvania
Starkey, Thomas Earl	New Jersey
Stein, Bessie	Pennsylvania
Steinberg, Samuel S.	Pennsylvania
Stief, Bernard H.	Pennsylvania
Stouffer, Chester Beals	Pennsylvania
Stout, Lynn Francis	Pennsylvania
Streen, Paul	New Jersey
Suconick, Max Herbert	Pennsylvania
Teah, Philip Ash	Pennsylvania
Tobachnick, Pauline	Pennsylvania
Tobachnick, Samuel	Pennsylvania

Name	Where From
Train, H. Jane	Pennsylvania
Wagner, Vernon Wilbert	Pennsylvania
Wagaman, Emmet E.	Pennsylvania
Weaner, Howard H.	Pennsylvania
Weinberg, Reba	Pennsylvania
Weinstein, Leah	Pennsylvania
Weiss, Joseph F.	Pennsylvania
White, Edward R., Jr.	Maryland
Winslow, Frank T.	New Jersey
Wisman, Maynard G.	Pennsylvania
Zacharias, Dixon Scott	Pennsylvania
Zahn, Joseph Emerson	Pennsylvania
Zimskind, Joshua N.	New Jersey
Zucker, Wm. Meyer	Pennsylvania

Students Who Have Completed the Scholastic Requirements of the Course and Who Will Receive Their Diploma Upon Reaching Their Majority.

Name	Where From
Althouse, Harry	Pennsylvania
Bitner, Richard Mathias	Pennsylvania
Connor, Edwin John	Pennsylvania
Freedman, Jacob	Pennsylvania
Gorgas, Thos. A., Jr.	Pennsylvania
Heffner, Edgar F., Jr.	Pennsylvania
Hodnett, Walter Reuben	Pennsylvania
Killen, William H.	Pennsylvania
Lipsky, Benjamin	Pennsylvania
Lissy, Joseph Myer	Pennsylvania
Pines, Charles Clifton	Pennsylvania
Rhoads, Lemuel Gilbert	Pennsylvania
Roeder, Paul S.	Pennsylvania
Shechter, Edward	Pennsylvania
Snyder, Louis Elliott	Pennsylvania
Staub, Brown Charles	Pennsylvania
Tunitsky, Samuel M.	Pennsylvania
Von Stanley, Eugene	New Jersey
Wolf, Sylvia Julia	Pennsylvania
Yohe, Harold Reon	Pennsylvania

Students Who Have Completed the Scholastic Requirements of the Course and Who Will Be Eligible for the Degree of Graduate in Pharmacy When Other Graduation Requirements Shall Have Been Met.

Name	Where From
Adams, Howard Ruby	Pennsylvania
Arkans, Morris	Pennsylvania
Askin, Martin	Pennsylvania
Belov, Abraham	Pennsylvania
Bernholz, Ida	Pennsylvania
Bernstein, Abe Meyer	Pennsylvania
Brown, Sara	New Jersey
Calvert, Ralph L.	Pennsylvania
Cardamone, Michael J.	Pennsylvania
Carlisle, Mildred F.	Pennsylvania
Cawley, Ellen	Pennsylvania
Coult, Sam	New York
Detwiler, David R.	Pennsylvania
Dyen, David Leonard	Pennsylvania
Eby, Wilmer Morrison	Pennsylvania
Fox, Sereck Hall	Pennsylvania
Goldberg, Anne	Pennsylvania
Griesing, Sterling Myers	Pennsylvania
Groff, Wm. Shakespeare	Pennsylvania
Gross, William Henry	Pennsylvania
Hetrich, Martin Luther	Pennsylvania
Hubbard, Gerald DeVon	Pennsylvania
Kauffman, Israel Harry	Pennsylvania
Keesal, Sarah	Pennsylvania
Korost, Leonard A.	Pennsylvania
Lieberman, Anna	Pennsylvania
Lipschultz, Maxwell E.	Pennsylvania
McCandless, J. P., Jr.	Pennsylvania
McFadden, Thos. J.	Pennsylvania
Marsteller, Harold W.	Pennsylvania
Mattern, Russell K.	Pennsylvania
Moyer, Ella Louise	Pennsylvania
Padgette, Elizabeth D.	Pennsylvania
Palomeque Eduardo	Mexico

Name	Where From
Paul, John Leroy	Pennsylvania
Paxson, George W.	Pennsylvania
Rabinowitz, Morris	Pennsylvania
Rapp, Ernest K. D.	Pennsylvania
Rosen, David	Pennsylvania
Rosenfield, Albert Wm.	New Jersey
Russell, Miriam Fay	Pennsylvania
Solorzano, Porfirio	Nicaragua
Specter, Simon Louis	Pennsylvania
Stagmer, Robert Irving	New Jersey
Staub, Luther Slifer	Pennsylvania
Stoner, John David	Pennsylvania
Young, Elvin Chester	Pennsylvania
Ramanuskas, Peter Paul	Pennsylvania

Certificate of Proficiency in Chemistry.

Abrahams, Harold Justin	Pennsylvania
Dinger, Allen LeRoy	Pennsylvania
McNerney, Frank M.	Delaware

Certificate in Bacteriology.

Bern, Morris	Pennsylvania
Conold, Clarence Carl	Ohio
Crenshaw, Katharine H.	Pennsylvania
Hoffstein, Esther S.	Pennsylvania
Koller, William Sides	Pennsylvania
Kreider, Obed Emmert	Pennsylvania
Lamm, Jasper Herman	N. Carolina
Lutz, Wilbur P.	Pennsylvania
MacMahon, Francis J.	Pennsylvania
Moody, Fred Leroy	Pennsylvania
Patterson, George W., Jr.	Pennsylvania
Stephens, Sylvia Fay	Pennsylvania
Vaile, Thomas	Missouri

Certificate in Clinical Chemistry.

Bern, Morris	Pennsylvania
Crenshaw, Katharine H.	Pennsylvania
Hoffstein, Esther	Pennsylvania

Name	Where From
Guest, Warren R.	New Jersey
Koller, William Sides	Pennsylvania
Kreider, Obed Emmert	Pennsylvania
Lamm, Jasper Herman	N. Carolina
Lutz, Wilbur P.	Pennsylvania
MacMahon, Francis J.	Pennsylvania
Patterson, Geo. Wm., Jr.	Pennsylvania
Sholl, Walter Douglas	Pennsylvania

Certificate in Cosmetics and Perfumes.

Gryning, John F.	Pennsylvania

Certificate in Physiological Assaying.

Butts, Donald Chas. A.	Pennsylvania
Bright, Charles A.	Pennsylvania
Henrie, Robert R.	Pennsylvania
Lieber, Maurice Lewis	Pennsylvania
Miller, George Alvin	New Jersey
Palomeque, Eduardo	Mexico
Shechter, Edward	Pennsylvania
Sless, Ephraim G.	Pennsylvania
Sharadin, Ralph	Pennsylvania

Certificate in Advanced Commercial Training.

Martin, Frederick A.	Pennsylvania
Rupp, Paul Frederick	Ohio
Zeisig, Harry C.	Pennsylvania

Countries and States Represented.

Pennsylvania	196
North Dakota	2
Virginia	1
Porto Rico	1
Texas	1
Missouri	4
Tennessee	1
Ohio	4
New Jersey	18

Name	Where From
Wisconsin	1
Indiana	1
North Carolina	2
Maryland	2
Mexico	1
Nicaragua	1
Delaware	1
New York	1
Total	238

ABSTRACTED AND REPRINTED ARTICLES

STANDARDIZATION OF ADRENALIN.*

An extremely interesting paper on the necessity of the physiological standardization of adrenalin, and of preparations of the suprarenal gland, was presented by M. M. Tiffeneau at a recent meeting of the Society of Pharmacy of Paris. M. Tiffeneau commenced by stating that of recent years adrenalins of varying degrees of purity had been placed on the market, and that he had had occasion to analyze products containing 40 and as much as 60 per cent. of foreign bodies, mostly consisting of ammonium-magnesium phosphate. M. Gérard, chief of the therapeutic laboratory of the faculty of medicine, even found a preparation, sold under the name of adrenalin, which contained no trace whatever of the active principle of the suprarenal, and was devoid of any specific action. On the other hand, he had met with adrenalins which, while proving to be chemically pure, exhibited only one-half of the physiological action of the official product. These proved to be synthetic products, representing the racemic form of adrenalin. This variation in activity, and the fact that substitutes are offered in the place of the official product, apart from its adulteration, render it imperative to establish a strict method of physiological standardization for this important remedy, as it is

*Reprinted from *Chemist and Druggist*, May, 1921.

only by this means that its efficacy can be established. Detailing his ten years' experience in handling adrenalin and preparations of the suprarenal gland, M. Tiffeneau described his researches, and the methods adopted for the evaluation of these products. The most reliable method of establishing the physiological activity of adrenalin consists in comparing in the same animal the variations in the arterial blood pressure produced by injections of these products. An adrenalin of absolute purity and full activity is used as the standard. For these tests the dog is found most suitable, and the animal is first anæsthetised and then given an injection of atropine sulphate in the proportion of one milligram for every kilogram of body weight. Without entering into the details of the test, minutely described by the author, it may be stated that it is based, first of all, upon establishing by a series of tentative injections of a 1 : 10,000 solution of the standard adrenalin the most convenient increase in blood pressure produced, which is 6 cm. to 8 cm., corresponding to an increase of pressure of 12 cm. to 16 cm. of mercury. It was generally found that this was effected by a dose varying between 2/100 and 6/100 of a milligram of standard adrenalin. As a result of his exhaustive researches, M. Tiffeneau was able to establish that natural lævogyrate adrenalin possesses a vasoconstrictive action which is more than double that of the racemic (synthetic) product, the exact relationship being 1 = 0.46, and from this may be inferred the dangers attending the use of a product not possessing the full activity of the official substance, particularly in the case of so active a drug. In describing his investigations on various preparations of the suprarenal glands, in the form of a desiccated powder, and as extracts of the glands, the author stated that he had established that one kilo. of fresh suprarenal gland obtained from horses contained on an average 2 grams of adrenalin. Since the loss incurred in desiccation and by removing the fat amounts to about 80 per cent., it follows that 100 grams of desiccated suprarenal gland corresponds to 500 grams of fresh gland (of horses), and contains 1 gram of adrenalin, the standard also adopted by the United States Pharmacopœia. With one exception, the commercial products complied with this standard, and, indeed, some samples examined showed a slightly higher content of adrenalin. Of interest is the observation that if carelessly stored—*i. e.*, kept in imperfectly closed bottles and exposed to light—desiccated preparations of the suprarenal gland at the end of a year show a loss of about 50 per cent. of their original content of adrena-

lin. While the desiccated preparations of the suprarenal gland were found to contain the correct proportion of adrenalin; this, the author stated, did not apply in the case of preparations obtained by extracting the glands, whether intended for injection or not, and none of the commercial samples of this class of suprarenal preparations contained the amount of adrenalin which should have been normally present. This he ascribes principally to the lack of sufficient precautions in carrying out the various manipulations entailed in extracting the glands, especially to the use of a solvent not sufficiently acid to dissolve the adrenalin in the glands. Finally, M. Tiffeneau urged the need for establishing the standard chemical tests for the evaluation of each of the various organo-therapeutic products used in medicine, and, in the absence of a satisfactory chemical test, of ascertaining a reliable method of physiological assay. Should it be found that these means are inadequate, he submitted that the manufacture of this class of products should be placed under efficient supervision by controlling the various stages in the process of manufacture, or that such establishments should be licensed.

BRAZILIAN BATIPUTA BERRIES.*

By Consul C. R. Cameron, Pernambuco.

Batiputa berries are the product of the sandy, rolling, coastal regions of the States of Parahyba do Norte, Rio Grande do Norte, and Pernambuco, Brazil, where they are prized for their oil, which is said to be equal to the best olive oil and is used for about the same purposes as the latter, having both food and medicinal value. Batiputa berries are of two varieties, wild and domestic. Wild plants are said to average about 100 to the acre, but the distribution is very irregular, being dependent upon natural seeding. The shrubs are only 7 or 8 feet high, however, so that they would doubtless flourish if planted as close as 10 feet apart, or, say, 400 or more to the acre.

Probably most of the land on which the batiputa shrub is found is owned by the State governments, but considerable tracts have come into private possession, and these are generally valued at from $1 to $10 per acre. Public lands, however, may usually be obtained by

*Reprinted from *Commerce Reports*, June, 1921.

any one of three ways, namely, homesteading, outright purchase, or a kind of ground rental called aforamento.

The batiputa lands are fairly well provided with transportation facilities. Part of the area is near the lines of the Great Western of Brazil Railway Company (Ltd.), or the Central Railway of Rio Grande do Norte, and a considerable part of the remainder is accessible by automobile and light truck, but pack mules and horses continue to furnish the standard means of transportation in the interior.

NEWS ITEMS AND PERSONAL NOTES

SEVENTH ANNUAL EXPOSITION OF CHEMICAL INDUSTRIES TO BE HELD AT NEW YORK.—Every State in the Union will be represented at the Seventh National Exposition of Chemical Industries, which will be held in the Eighth Coast Artillery Armory, Jerome Avenue and Kingsbridge Road, New York City, during the week of September 12th. This is assured by the early list of those that have already secured space, and from the outlook the display this year will be far more important than its predecessors. One phase of the situation that is giving Managers Fred W. Payne and Charles F. Roth no little difficulty is finding room for the many new concerns that want to exhibit. Already more than 400 applications for space have been made and there is no doubt but that last year's record of 457 exhibitors will be eclipsed.

This year's exposition will be more international in aspect than any of the six preceding it for the reason that it will follow immediately after the convocations of chemists from all parts of the world that will be held in New York City early in September.

THE HOROVITZ BIOCHEMIC LABORATORIES.—The Horovitz Biochemic Laboratories announce the opening of their new manufacturing laboratories at 220 East Fourth Street, Cincinnati, Ohio. Dr. A. S. Horovitz will personally supervise the manufacture of the firm's products.

JOSIAH C. PEACOCK ELECTED PRESIDENT OF PENNSYLVANIA PHARMACEUTICAL ASSOCIATION.—Josiah C. Peacock, of Philadelphia, was the unanimous choice for president, while Buena Vista Spring was chosen after a friendly contest as the place for holding the forty-fifth annual meeting, June 20, 21 and 22, 1922.

President Peacock is a member of the Class of '91, Philadelphia College of Pharacy and Science, a trustee of that institution, and is chairman of the Centennial Committee on College Membership.

BOOK REVIEWS

"CHEMICAL REACTIONS AND THEIR EQUATIONS." By INGO W. D. HACKH. PH. C., A. B., Professor of Biochemistry, College of Physicians and Surgeons, San Francisco. P. Blakiston's Son & Company, Philadelphia; 138 pages $1.75 net.

The object of this book is "to supply students with necessary material and to expound the general principles of balancing equations," the author having observed that "the inability to balance a chemical equation is a most common difficulty of students of chemistry. It does not enter into a detailed discussion of physico-chemcal equations, but confines itself to a consideration of purely chemical equations from a technical and arithmetical standpoint."

Chapter I deals with Symbols and their use in expressing atoms, molecules and ions; Chapter II with Formulas of various kinds (empirical, rational, etc.), Valence and Valence Numbers, Oxidation and Reduction; Chapter III with Equations involving no Oxidation and Reduction; Chapter IV with Equations involving Oxidation and Reduction; Chapter V with Reactions and their Control; Chapter VI with Types of Chemical Reactions and Equations.

Reactions are illustrated with both molecular and ionic equations, and the methods used in balancing them. Under Control are considered the influence of temperature, surface, catalysts, concentration, etc. Each chapter closes with a rather comprehensive set of questions and problems bearing upon or illustrating the matter therein, adding materially to the value of the book as a student's companion.

Following the six chapters mentioned are to be found: Appendix I, Key to Nomenclature of Chemical Compounds; Appendix II, Displacement Series; Appendix III, The Periodic System and Classification of the Elements; Appendix IV, Solubility Table of Compounds; Appendix V, Preparation of Salts and Key to Equations, and, finally, a very useful Index and Glossary.

The type and composition of the book are satisfactory and the language clear and concise, but the volume shows numerous evidences of the lack of the careful proof reading that should be given all text-books, and particularly those in which much of the text is in the form of formulas or equations in which every letter, figure and other character counts for so much.

The reviewer unhesitatingly recommends the book to any person who desires a clear, compact treatise on equation writing.

F. P. S.